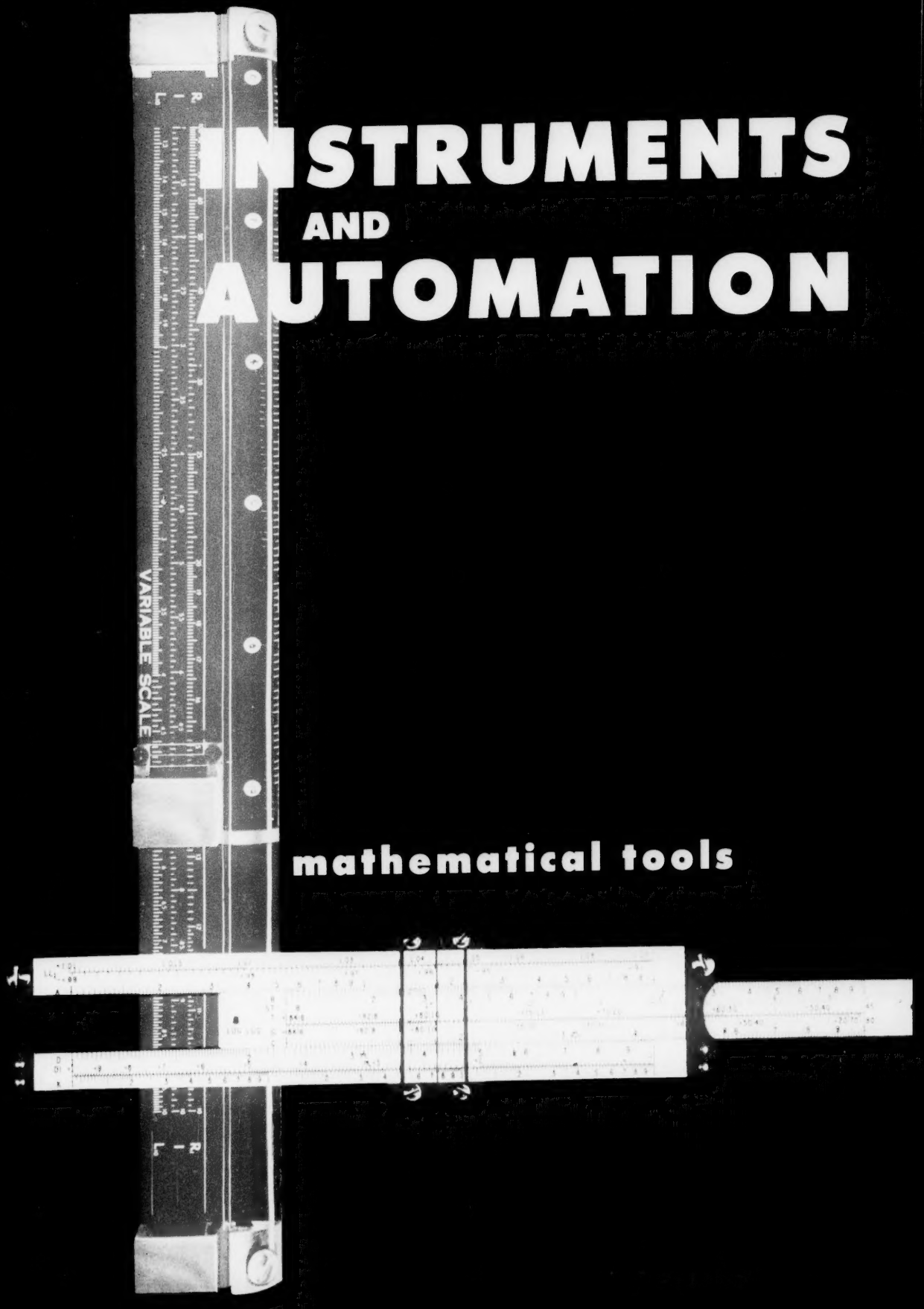
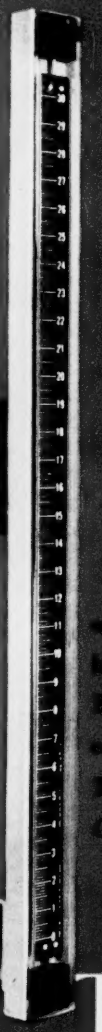
INSTRUMENTS AND AUTOMATION



mathematical tools

***Trimount** presents a new primary standard for pressure measurement. New in concept, new in design, this manometer outmodes the U tube as a pressure measuring device!*



Trimount's model C-22 manometer* opens new vistas of accurate pressure measurement and data computation based on principles applicable anywhere on earth or in the universe! Be certain of ultimate accuracy in your work, ask for Trimount's new catalog and technical brochure illustrating the instruments and principles applied.

Trimount Instrument Company, 3119 West Lake Street, Chicago 12, Illinois.

Designers and builders of the world's most accurate manometers

Trimount

LEWIS MODEL 73 PO

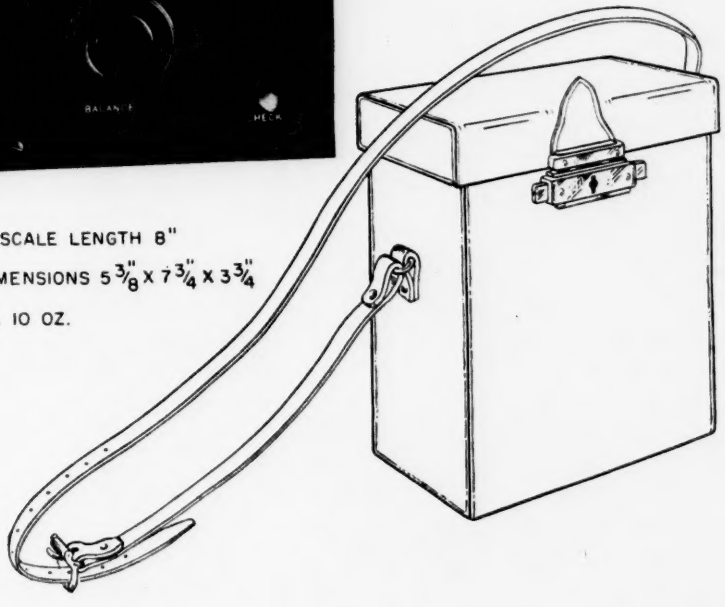
PORTABLE

PYROMETER POTENTIOMETER

FOR MEASURING TEMPERATURES
electrically

- IN MOVING VEHICLES
- IN AIRCRAFT
- IN THE LABORATORY

30 STANDARD RANGES AVAILABLE TO FIT MOST REQUIREMENTS



TEMPERATURE SCALE LENGTH 8"

INSTRUMENT DIMENSIONS $5\frac{3}{8}$" X $7\frac{3}{4}$" X $3\frac{3}{4}$"

WEIGHT 4 LBS. 10 OZ.

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NAUGATUCK, CONNECTICUT

Manufacturers of Complete Temperature Measuring Systems for Aircraft

For more information circle **2** on inquiry card.

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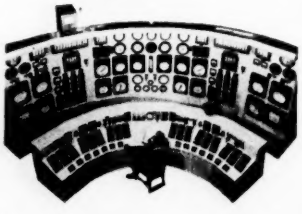
Housings are needed to bring order out of chaos, to protect instruments, assure their proper performance, and the efficient control of complex operations.

FALSTROM's many years of experience in producing custom control panels, graphic panels, consoles and housings of all kinds may help you to better design at lower cost.



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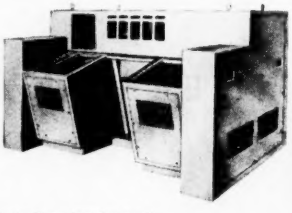


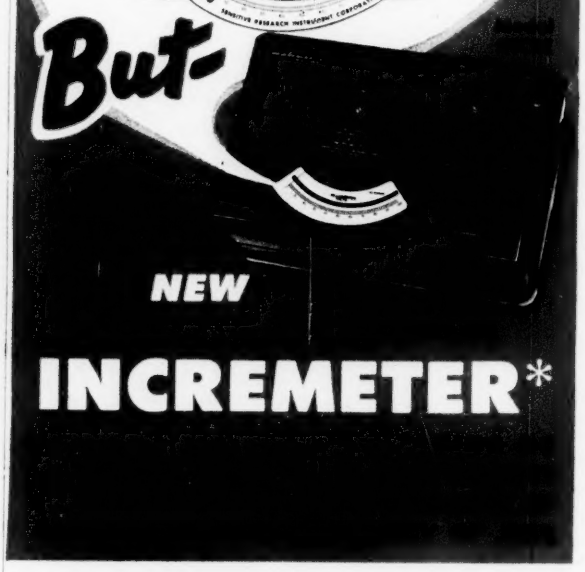
FALSTROM COMPANY

Custom Metal Fabricators since 1870

109 Falstrom Court
Passaic, New Jersey

For more information circle **3** on inquiry card.

THIS MAY SEEM LIKE A LOT OF SCALES FOR *ONE* INSTRUMENT



The Model INCRE essentially consists of a differential instrument of "high comparison accuracy" and a stable "high accuracy" reference source. The instrument's actual scale length is 6.3", but this represents only 10% of its total effective scale length. Each 10% of its full scale range is selected by an incremental switch thereby creating a 90% scale suppression at all times. ***Ranges*** – single or multirange from 200 mv. full scale (lowest reading .2 mv.) and 200 microamperes full scale (lowest reading .2 microamperes). ***Resolution*** – effectively 1,000 scale divisions over a 63" scale length. Each scale division has a value of .1%. ***Availability*** – portable or as a rack-mounted edgewise panel instrument. **The SRIC Differential "63" Incremeter** is a high resolution, *phenomenally* accurate measuring device with proven stability because it *is* an Electrical Indicating Instrument.

Diamond Pivoted of course!

Write for additional information on the *NEW* "INCREMETER."

Symbol of Quality

For more information circle **4** on inquiry card.

INSTRUMENTS AND AUTOMATION

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—MHA

NOVEMBER 1958

NO. 11
VOLUME
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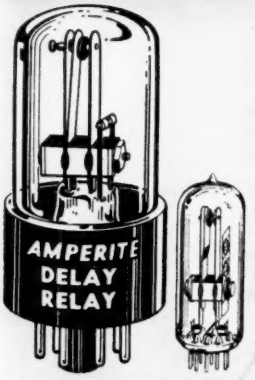
AMPERITE

THERMOSTATIC
DELAY RELAYS



2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are **rugged, explosion-proof, long-lived, and—inexpensive!**

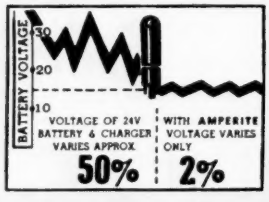
TYPES: Standard Radio Octal, and 9-Pin Miniature . . **List Price, $4.00.** Standard Delays

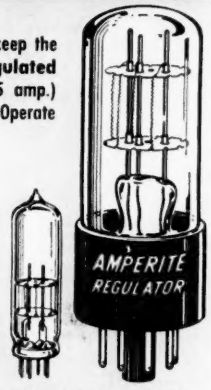
Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

AMPERITE
BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit **automatically regulated** at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.





Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55° to +90° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

AMPERITE
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In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

For more information on Delay Relays circle **154** on inquiry card.
For more information on Ballast Regulations circle **1** on inquiry card.

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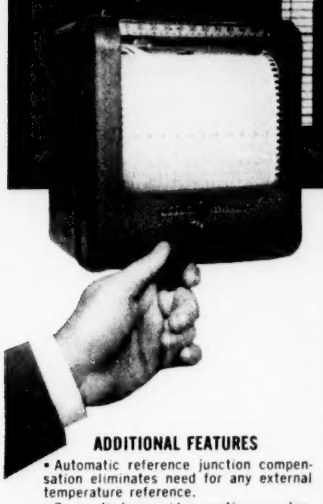

the Varian Thermocouple Recorder

RANGES EASILY CHANGED BY CONVENIENT PLUG-INS

Typical spans are −150° to +250°F., 0° to 400°F., 0° to 2200°F. and many others. Fahrenheit or centigrade charts and scales are available for all ranges. Plug-in range elements are low in cost and readily accessible on the recorder control panel. They match iron-constantan, copper-constantan or chromel-alumel thermocouples as appropriate to range and environment.

PORTABLE OR SMALL-SPACE PANEL VERSIONS

An easy-to-carry 15 pounds, the Varian temperature recorder can be moved anywhere throughout the laboratory, plant, field or customer location. In its panel version, the recorder is a space saver, needing only an $8\frac{9}{32}$-inch width and $10\frac{1}{2}$-inch height. On a standard 19-inch rack, two Varian recorders can be mounted side by side.

ADAPTABILITY TO MULTIPLE USES

Because of its handy size, plug-ins and chart-speed options, the Varian temperature recorder is equally suitable for your research and development laboratory, in-plant investigation of temperature problems, operational checkout of products that involve heat, or trouble shooting at your customers' locations.

ADDITIONAL FEATURES

- Automatic reference junction compensation eliminates need for any external temperature reference.
- Zener diode provides continuous electronic voltage reference source.
- 5-inch recording width on 85-foot rolls; temperature-calibrated charts available for all ranges.
- Reliable servo operated null-balance potentiometer principle as used on large panel instruments.
- Limit of error 1% of full span.
- One, two or four chart speeds with options from ⅛th inch per hour to 8 inches per minute.
- Interchangeability of input chassis allows conversion of all Varian G-11 and G-11A recorders to temperature recording or vice versa.
- Base price only $545.

Varian recorders are sold and serviced by representatives in principal U. S. cities and abroad. Write today for literature and name of representative in your area.

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For more information circle **8** on inquiry card.

Announcing

Epsco's **NEW**

DVOM

MAJOR ADVANCE

½ ACTUAL SIZE

Epsco

First in data control

DIGITAL IN VOLT-OHM METERS

FULLY TRANSISTORIZED

NO STEPPING SWITCHES • NO RELAYS

• **VERSATILE** accurately measures both resistances and AC-DC voltages and counts external events, too! Directly drives printers, punches and memory storage units and can be directly used as a bi-directional telemeter.

• **FAST** less than 2 millisecond reading time . . . up to 100 completely independent measurements per second for any system use.

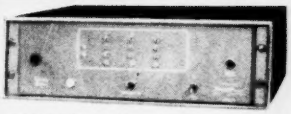
• **EASY TO READ** in-line, in-plane visual display . . . lamp life up to 10,000 hours . . . numerals 1⅛ inch high . . . automatic indication of polarity, decimal point and mode of operation.

True dependability and versatility have at long last come to digital volt-ohm meters in EPSCO'S new DVOM. Fully transistorized . . . adjustment-free . . . no stepping switches or relays. Provides precise numerical measurement of AC-DC voltages, resistances . . . fast, accurate visual or printed quality control data . . . high-speed data acquisition for direct print-out or storage . . . remote indication and data transmission over a single line. Compact, lightweight, portable — also for rack-mounting. Write for Bulletin 95801, Epsco, Inc., Equipment Division, 588 Commonwealth Ave., Boston 15, Mass.; in the West: Epsco-West, 125 E. Orangethorpe Ave., Anaheim, California.

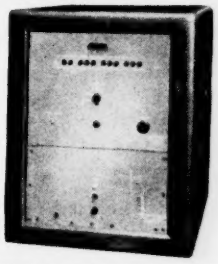
DVOM price.....$1,475

Ask for a demonstration.

MODEL DA-102 Wide-band, Low-level Chopper-stabilized, Differential DC Amplifier with very high open-loop gain . . . unparalleled stability, high common mode rejection, wide band width. Bulletin 105801

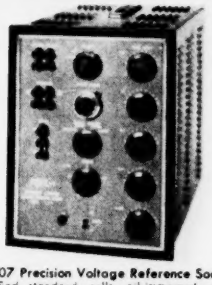


TRANSICON DATRAC. Lowest-cost, fully reversible voltage-digital converter available anywhere . . . fully transistorized . . . no adjustments . . . up to 25,000 conversions/sec. analog-to-digital; up to 100,000 digital-to-analog . . . Bulletin 95805



MODEL B DATRAC. Still highest speed voltage-digital converter on the market . . . fully reversible . . . permits up to 44,000 conversions/sec . . . ±0.05% ± ½ least significant bit accuracy . . . no calibrations or adjustments required. Bulletin 95807

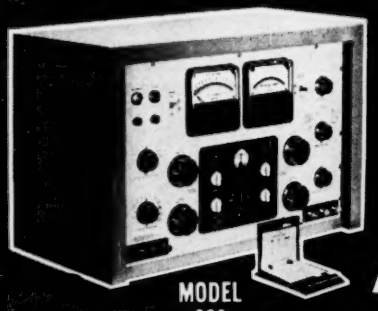
DYKOR High-speed Photoelectric Reel & Strip Papertape Readers. Up to 600 characters per second . . . less than 2 millisec start and stop times . . . all solid state reading heads and amplifiers. Bulletins 95803 and 95804



VR-607 Precision Voltage Reference Source. Certified standard cells, oil-immersed ultra-stable resistors and high-gain chopper-stabilized amplifiers ensure 0.01% absolute accuracy. ±111.112 volts d-c range . . . 0.1 millivolts resolution down to zero volts . . . 0.005% stability. Bulletin 95806

For more information circle **6** on inquiry card.

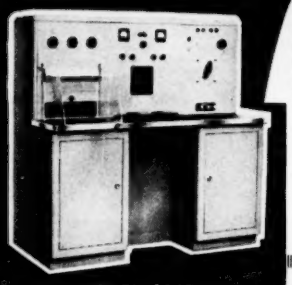
Instrument Calibration



MODEL 829

a modern method of maintaining ACCURACY

Superior and sustained quality control, through frequent calibration of test instruments, can be achieved by semi-skilled personnel using these self-contained standards.



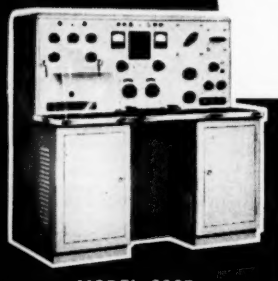
MODEL 261B

Portable Model 829 calibrates both AC and DC meters over ranges from 0.25 millivolt to 2000 volts and 2 microamperes to 20 amperes. Direct reading accuracy of 1% (0.5% using charts supplied). Output frequency from 50 to 400 cps depending on line frequency used.

Net price $2,650.

Console Model 261B calibrates all types of AC meters to direct reading accuracies of 0.5% (0.25% using calibration charts) over frequency range of 50 to 1600 cps. Current range from 1.5 milliamperes to 200 amperes; voltage range from 75 millivolts to 1500 volts. Output of electronic power oscillator has less than 5% total harmonic content at 60 cycles.

Net price $9,250.



MODEL 262B

Model 262B Dual Potentiometer Standard calibrates DC electrical measuring instruments to direct reading accuracies of 0.1% (0.05% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes. Employs Weston instruments and standard cells.

Net price $15,600.

Prices are f.o.b. Boonton, N.J. & subject to change without notice.

WE CAN HELP YOU

Technical and application data for our six basic models are fully described in a new 24-page catalog. Send for it today.

RFL *Radio Frequency* LABORATORIES, INC. Boonton, New Jersey, U.S.A.

For more information circle **7** on inquiry card.

to the editor

Editor, I&A:

I wish to congratulate you on a very fine magazine. It sure is a help and money saver to us. Above all, it saves us time and provides some very useful and interesting information. My only regret is that I did not discover it sooner.

Gordon V. Gonion
Automotive Electronic Specialties
Glenview, Ill.

Editor, I&A:

From time to time I have been stimulated by your articles and editorials in *Instruments and Automation.*

One area that you seem to have been championing of late is that of systems engineering as a profession apart from professional engineering. As I recall, there was an effort made at the International Automation Exhibition at the Coliseum in New York in June of this year to get interested engineers together at that time to discuss the possibility of a systems engineer council.

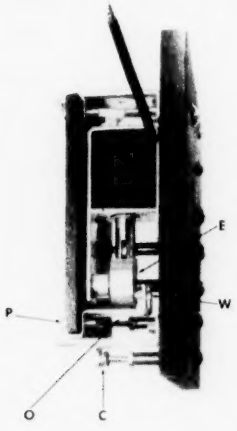
What were the results of this discussion? I should appreciate your letting me know what happened. I had hoped to attend this meeting but my schedule was such that this was not possible.

Although the subject of feedback control systems, information handling systems, and automatic control systems have served to emphasize the systems aspect of engineering problems, actually from a historical point of view, electrical engineers have faced many systems problems in the past, and through their technical societies and professional engineering associations, have been able to handle them satisfactorily. The commercial electric power systems, the telephone systems, and the radio and TV systems have all been of large magnitude and of large public impact. In these cases, there has not to my knowledge been any rules stating that the engineering and the hardware for such activity need be handled by separate companies or separate engineers.

It is my impression that through free competition and the mechanism of the economic market, the engineering and the equipment going into making up a system would, in the long run, turn out to be that which was most economically sound. I feel

Continued on page 1750

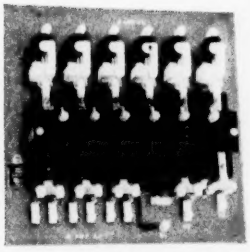
ASCO mechanically held relays are power driven in both directions with no dependency on hooks or latches for operating or mechanically holding contacts



The Unique ASCO Mechanically Held Movement

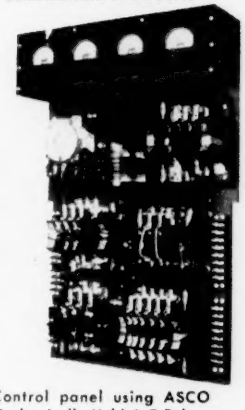
When the solenoid is energized, eccentric cam (E) is rotated. Weight drive pin (W) causes movement of operating lever (O). Lever (O) (connected to the contact finger block) rotates on pivot pin (P) and contacts such as (C) are opened or closed.

Note that with the solenoid de-energized, the entire mechanism is firmly locked in place by the angular position of the linkages — no hooks, latches, or semi-permanent magnets are required!



Special ASCO Relay with 6 D-C Poles for 600 volts, 3 A-C Poles for 230 volts and 125 volts D-C control. Note Blow-outs on D-C Poles.

ASCO Mechanically Held Relays A-C and D-C . . . to 25 Amperes Combinations to 24 Poles



Control panel using ASCO Mechanically Held A-C Relays (Bulletin 1256-168). Notice multiple pole and double throw arrangements.

ASCO Power Driven Relays with No Hooks or Latches:

- Provide higher contact pressures
- Minimize the possibility of contact welding
- Insure positive operation

Design simplicity is provided in ASCO Mechanically Held Relays through use of a single solenoid coil mechanism. The coil is momentarily energized during the instant of operation only. This momentary surge of power electrically operates the relay to *open and close* contacts; thus the relay is power driven in both directions, with no dependency on hooks or gravity for operating and mechanically holding the contacts.

FEATURES

• No A-C hum or chatter • Operate in any position • Compact construction permits mounting on metal surfaces or panelboards • Operated by single-coil mechanism—positive in each direction • Silver contacts rigidly locked open or closed by angular relation of linkages—no delicate hooks or latches • Signal lamps require no extra contacts or control wires • Enclosed rating same as open rating due to liberal design and momentary mechanism without coil losses • All parts finished in cadmium plate or black to present good appearance and to match larger ASCO Switches.

APPLICATION

ASCO Mechanically Held Relays are used for automatic or remote control where A-C hum or chatter is objectionable, where coil loss is undesirable or where relays must not change position when the control circuit fails (low voltage release). ASCO Mechanically Held Relays are often used for master control of other control equipment, to prevent loss of voltage or control failure. These relays are frequently used for electric heaters, lighting, and similar applications.

Mechanically Held Relays are only part of the complete line of Relays made by ASCO. Our Catalog 57-S4 lists:

MAGNETICALLY HELD RELAYS
A-C or D-C . . . Normally Open . . . Normally Closed . . . Double Throw

ASCO Magnetically Held Relays use a physical arrangement which parallels that of ASCO Rocker Type Mechanically Held Relays. Since the two types are similar in appearance, they help to increase the attractiveness of control panels, at the same time offering interchangeability of contacts.

SPECIALIZED RELAYS

. . . Reverse Current
. . . Time Delay
. . . Brake Winding Time Delay
. . . Close Differential
(Voltage and Current Types)
. . . Current Type, Welding
. . . Electronic
. . . Modified Arrangements

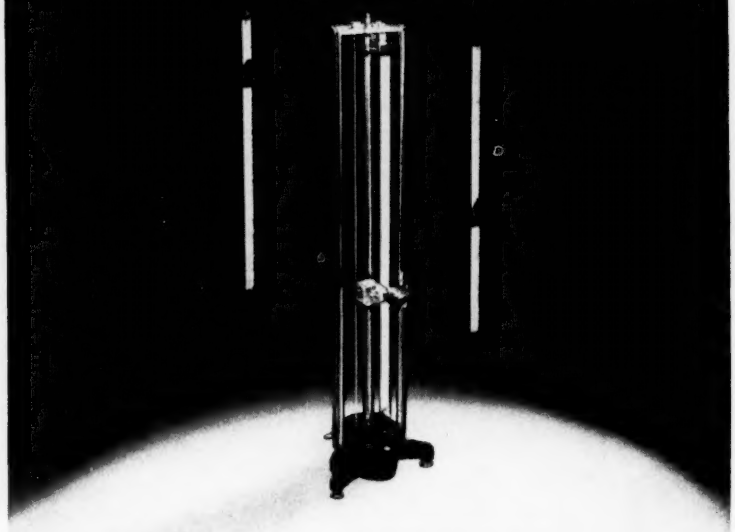
Write for your copy of "Relays by ASCO"—Catalog 57-S4.

Automatic Switch Co.
52-F Hanover Road, Florham Park, New Jersey
FRontier 7-4600

ASCO

For more information circle **5** on inquiry card.

Something Special
IN A STANDARD STANDARD



For those jobs, only a manometer can do . . .

When you're faced with precision calibration, production checks of other accurate instruments, or any kind of laboratory pressure work . . . in fact, any time you need better than 0.1% accuracy that's the time to add a W&T precision mercurial manometer.

Rapid readout with the magnified magnetic vernier makes exact pressure readings easy. All 'round leveling, temperature compensation and gravity correction are included, of course.

range: 0 to 31.50 inches Hg., or any other desired pressure unit of equivalent range.

accuracy: 1/5000 over full scale.

For full information on all models of W & T precision mercurial manometers, write Dept. A-121.00.

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

W&T MERCHEN SCALE FEEDERS & METERS

for Automatic Batch Control
Continuous Blending
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Control the feeding of ingredients by weight to an accuracy of 1%.
Capacities range from 3 to 3000 lbs. per min.

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M-31.48

For more information circle 9 on inquiry card.

LETTERS—CONTINUED

that there are many existing societies in the engineering field which are concerned with the technical information behind systems engineering. These societies warrant support before we rush headlong into setting up new systems engineers organizations which would be competing for the same technical talent and interest that the many existing societies do.

To what extent have these matters been discussed by the interested systems engineers with the existing technical and professional societies?

Your book "*Digital Techniques for Computation and Control*" has been of considerable interest to me, and I am pleased to see that *Instruments and Automation* is making possible the more rapid dissemination of knowledge in this very rapidly moving field of automatic control and information handling.

Harold Chestnut
Control Systems Engineer
General Electric Co.
Schenectady, N. Y.

The matters you discuss regarding Systems Engineering were the subject of the meeting held at the Fourth Automation Exposition. There are two schools of thought:

First is the school of thought you outline in your letter, which states that (1) most engineering problems have systems implications, (2) engineers have always faced these problems, (3) there is no need for engineering and hardware to be handled separately, (4) existing societies are aware of the basic problems and can solve them, (5) the free play of a free market will establish what is and what isn't economic.

The second school of thought says (1) something new—systems engineering—has appeared on the instrumentation scene, (2) systems engineering involves hardware of many manufacturers, (3) some manufacturers are giving away the engineering in order to sell hardware, (4) consulting engineers with systems backgrounds are being faced with unfair competition because of this, (5) the free play of the market isn't working because many firms are deliberately losing huge amounts of money, giving away free engineering in order to get a few products on the market, (6) the non-hardware producing consultants had better organize their own society to protect their interests.

The January, 1958 issue of INSTRUMENTS AND AUTOMATION

shows that there is plenty of evidence to support each of these positions—and those who attended the Systems Engineering Council meeting represented both positions.

A detailed report on that meeting will appear in a future issue of INSTRUMENTS AND AUTOMATION. Meanwhile, those interested in such a Council are planning to work at the local level on a few practical actions such as developing a roster of qualified systems engineering consultants.

If systems engineers do have problems that can be solved by mutual cooperation, a Council may result. If those who have such problems are not basically IRE or ASME or ACS men, it might be advisable to start as an independent organization.

We are delighted that you liked the "Digital" book.

Editor, I&A:

We are subscribers to your magazine and would be obliged if you could give us sources of information on Valve Positioners.

E. Singer
Singer Development Co.
Vancouver, B. C.

Our book "CONTROL VALVES" by Chet Beard (Instruments Publishing Co., $2.00) has a complete description of all American valve positioners—plus other valve actuators.

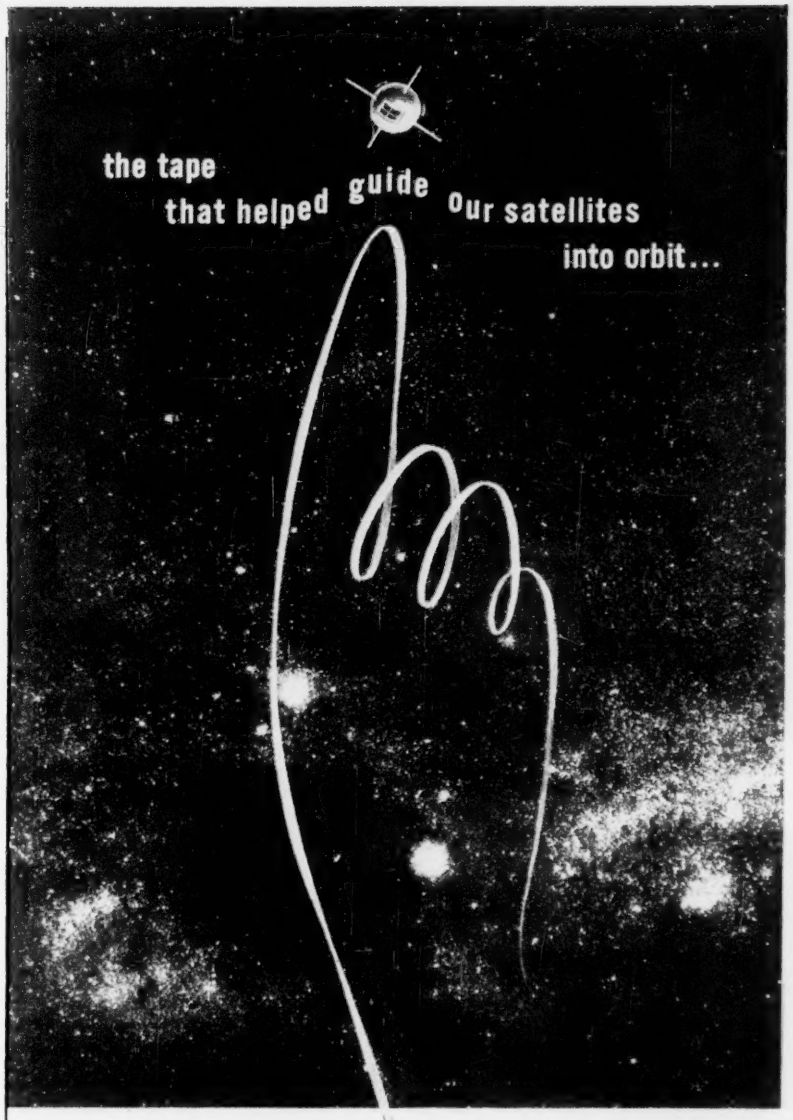
Editor, I&A:

I have recently read *Digital Techniques for Computation and Control* by M. L. Klein, H. C. Morgan, and M. H. Aronson, and consider it a very valuable basic text which can be used by any one of the scientific disciplines, including medicine.

In planning our research program in the Cardio-Pulmonary Laboratory, Doctor Harry Davis and I have repeatedly discussed the limitations imposed upon us by the laborious analysis of multiple simultaneously-recorded biologic variables. It is now our belief, considering the biological transducers which we use, that digital techniques and computer methods will materially add to our research program by making data readily available to us.

I would be interested to know if you are aware of any medical installations which utilize digital techniques and computers for their research program. Our own research projects involve recording 30 to 50 physiological variables simultaneously. These data are recorded from the cardiovascular and the respiratory systems. If you are aware of any firm having

Continued on page 1753



SOUNDCRAFT TYPE A TAPE FOR DIGITAL RECORDING

The Ford Instrument guidance system in Army Jupiter-C missiles that launched the Explorers into space... and the recording system in the Navy's Vanguard... employed a most reliable magnetic medium — Soundcraft Type A Tape. Only Soundcraft Type A Tape has electrical and physical stability to merit selection in these vital missions ...and in your own instrumentation applications. The RCCH oxide formulation in Type A Tape provides higher signal output and greater retentivity... plus unique surface hardness and high thermal stability. Soundcraft's exclusive Micro-polishing and Uni-level coating processes help provide the electrical and physical uniformity found only in Soundcraft Type A Tape. Send for detailed Type A Brochure!

One tape can't serve all needs...For Your Telemetering Applications... write for brochure on Soundcraft Type B Tape for Telemetering!

REEVES SOUNDCRAFT CORP.

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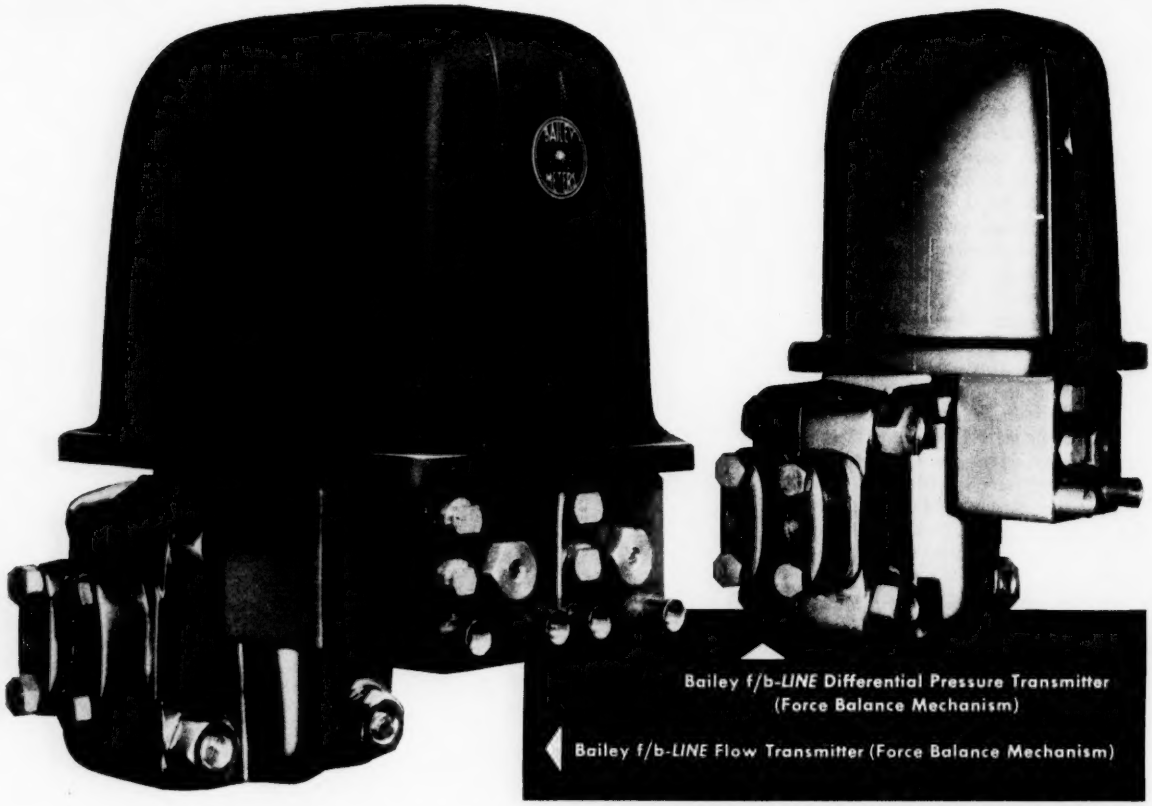

Bailey f/b-*LINE* Differential Pressure Transmitter (Force Balance Mechanism)

Bailey f/b-*LINE* Flow Transmitter (Force Balance Mechanism)

Two new Bailey *f/b-LINE* Transmitters

permit new accuracy in measuring flow and differential pressure

Pneumatically transmits rate of flow—or differential pressure—measurements to indicating, recording, and/or controlling equipment at remote stations. Transmitters consist of a diaphragm measuring mechanism and a force balance pneumatic transmitting unit.

APPLICATION

For steam, water, air, gases and other fluids producing differentials across primary elements from 0-2 in. H_2O to 0-2000 in. H_2O at maximum service pressure of 50, 1500, and 5000 psig.

FEATURES

Transmits a Signal Directly Proportional to Rate of Flow. Uses receiver with uniformly-graduated chart or scale. Eliminates need for external square-root extractors or characterizers.

10 to 1 Turndown. Differential range of each diaphragm measuring element may be changed by factor of 10 to 1; e.g., 0-20 in. H_2O diaphragm may also measure 0-2 in. H_2O.

Screwdriver Adjustments. Range and zero adjustments readily accessible. Range may be changed with screwdriver adjustment.

Overpressure Protection. Protects against full service pressure applied to either side of diaphragm.

Fast Response. No viscous dampers needed, so speed of response is very fast.

Corrosion Resistant. For maximum differentials between 20 and 2000" H_2O, all parts in contact with process fluid may be stainless steel. No sealing fluids or sealing diaphragm required.

Good Stability. Reset type boosters give good stability with high gain.

Versatile Mounting. May be mounted on process piping, wall, or separate mounting pipe using same bracket.

For additional information, call your local Bailey District Office, or write direct. G46-1

Instruments and controls for power and process

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For more information circle **11** on inquiry card.

LETTERS —CONTINUED

experience in applying the techniques mentioned above to medical research programs, I would appreciate hearing from you.

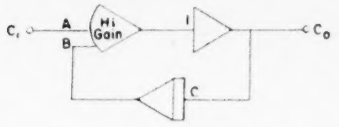
Again, may I say I feel the authors have presented this valuable material in splendid fashion.

J. Leo Wright, M. D.
Director, Cardio-Pulmonary Laboratory
Baptist Memorial Hospital
Memphis, Tenn.

Editor, I&A:

An article titled "Derivative Via Integration" on page 1525 of your Sept. issue contained an illustration of a high-gain amplifier and an integrator connected in a loop configuration. Patched together in this manner the high-gain amplifier would undoubtedly saturate because of the inherent positive feedback.

What the author, Mr. Fogiel, probably meant to show was the circuit given here. But even this is only an



$$G = +\frac{A}{B\,C}\,\frac{d}{dt}(e_i)$$

approximation because no operational amplifier is capable of producing the theoretically infinite voltage pulse that is required by a square wave input.

James E. Murray
Euclid 17, Ohio

Reader Inquiries

Magnetic-ink Tester

President of printing company seeks tester to determine magnetic properties of ink stripes on paper; also cross-section and ink film thickness within 0.005" A-349

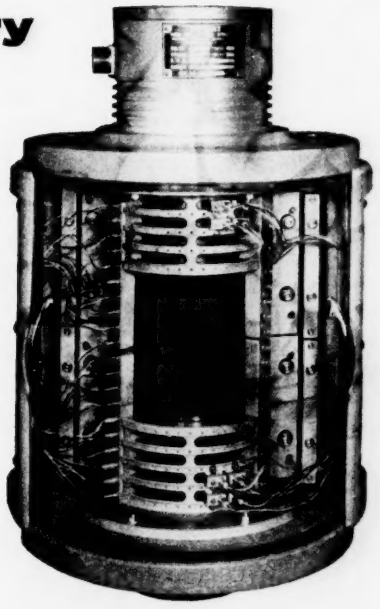
Timer Testing

Chief engineer of brush manufacturing company seeks equipment for checking accuracy of timers used in manufacturing processes. A-350

Computers in Medical Research Programs

Director of Cardio-Pulmonary Lab seeks contact with medical organizations which use digital techniques, digital data recorders, and computers in research programs. A-351

Improve Your Memory



with a standard multiple purpose off-the-shelf drum

The 512-A Bryant general purpose magnetic storage drum meets the exacting requirements of a production component, yet has the versatility necessary for laboratory work. This standard 5" dia. x 12" long drum is stocked for immediate shipment, complete with standard components such as general storage brackets, recirculating register brackets and magnetic read/record heads. Its low price reflects the benefits of Bryant's 25 years' experience in the efficient design and production of high speed precision spindles.

Features:

- Guaranteed accuracy of drum run-out, .00010" T. I. R. or less
- Integral drive – Bryant precision motor (1200 to 12,000 R. P. M.)
- Capacities to 625,000 bits
- Accommodates up to 240 magnetic read/record heads
- High density ground magnetic oxide coating
- Super-precision ball bearing suspension
- Vertical mounting for trouble free operation

Special Models: If your storage requirements cannot be handled by standard units, Bryant will assist you in the design and manufacture of custom-made drums. Speeds from 60 to 120,000 R. P. M. can be attained, with frequencies from 20 C. P. S. to 5 M. C. Sizes can range from 2" to 20" diameter, with storage up to 6,000,000 bits. Units include Bryant-built integral motors with ball or air bearings. Write for Model 512-A booklet, or for special information.

Remember . . . you can't beat a Bryant drum!

BRYANT COMPUTER PRODUCTS DIVISION

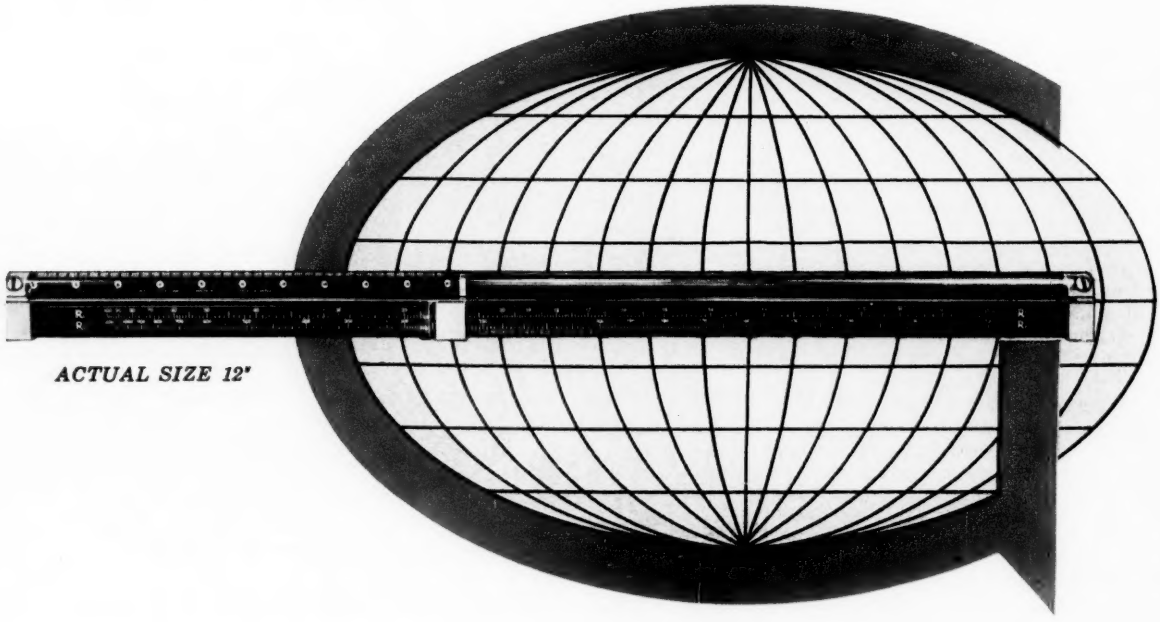
BRYANT CHUCKING GRINDER CO.

P. O. Box 620-I, Springfield, Vermont, U.S.A.

For more information circle **12** on inquiry card.

FOR A WORLD BUSY WITH DATA REDUCTION!

THE GERBER VARIABLE SCALE



ACTUAL SIZE 12"

Saves Time! Saves Errors! Saves Money!

Have you ever wished for a scale that can always scale your answers directly, instead of using a fixed scale and converting for each reading? That's the exact function of the Gerber Variable Scale, which can be likened to a high precision "elastic ruler".

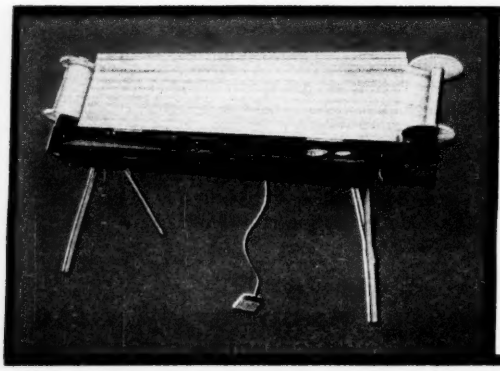
With high precision calibrated springs whose coils act as calibrating lines, this computer can be expanded for any ratio, any setting.

The Gerber Variable Scale saves you precious time in data reduction, decreases error, simplifies the solution of engineering problems, and is very inexpensive.

Send For Free Literature Now!

The Gerber Variable Scale is being used by all types of people in data reduction and research—scientists, engineers, designers and draftsmen, professors and students, statisticians, architects.

Send for descriptive free literature showing examples and applications.



GERBER OSCILLOGRAM SCANNER

Will scan a record up to 1,000 feet long with excellent tracking. Versatile drive system features adjustable running and braking tension as well as variable speed. Instant stopping. Reversible. Ask for literature giving complete specifications.

OTHER GERBER INSTRUMENTS

Gerber GraphAnalogue Computer with Graph Paper Insert for any arbitrary non-linear scaling.

Gerber Derivimeter, a new direct reading slope reader for data reduction.

Gerber Equameter for performing harmonic analysis and least square and polynomial equations on plotted or recorded curves.

Gerber Data Readers for automatic data reduction.

GSI GERBER SCIENTIFIC INSTRUMENT CO., 89 SPRUCE ST., HARTFORD, CONNECTICUT

For more information circle **45** on inquiry card.

trends

There are about 46,000 engineers, mostly electronic, employed by the computer manufacturing industry, reports Witty-Polon, management consultants—and more than 1700 computers in commercial and military use, with 3000 units on order.

EIA reports that sales of industrial electronics equipment in 1957 were $1.3 billion, 36% above 1956 and 271% above 1950-57 average. Sales in 1965 are expected to be $2.6 billion.

Daily consumption rate of liquid oxygen in USA in 1956 was 8400 tons, reports A. D. Little, Inc., expected to triple by 1966. Basic uses are in chemical reactions, steel production, high-altitude apparatus, and missile propulsion.

38,000 scientists and engineers are now employed in atomic energy field, reports AEC. Colleges and universities had an estimated 5400 scientists and engineers devoting at least part time to teaching and research in atomic energy during 1957-58 academic year; will increase to 5700 for 1960-61 year.

Operations Research Group of Case Institute of Technology is attempting to develop formulae for optimum research expenditures of (1) an individual firm, (2) an industry, such as chemical industry, and (3) effect on national economy.

National Aeronautics & Space Administration estimates that USA will spend $65 million on space science and $82 million on space technology in fiscal 1959.

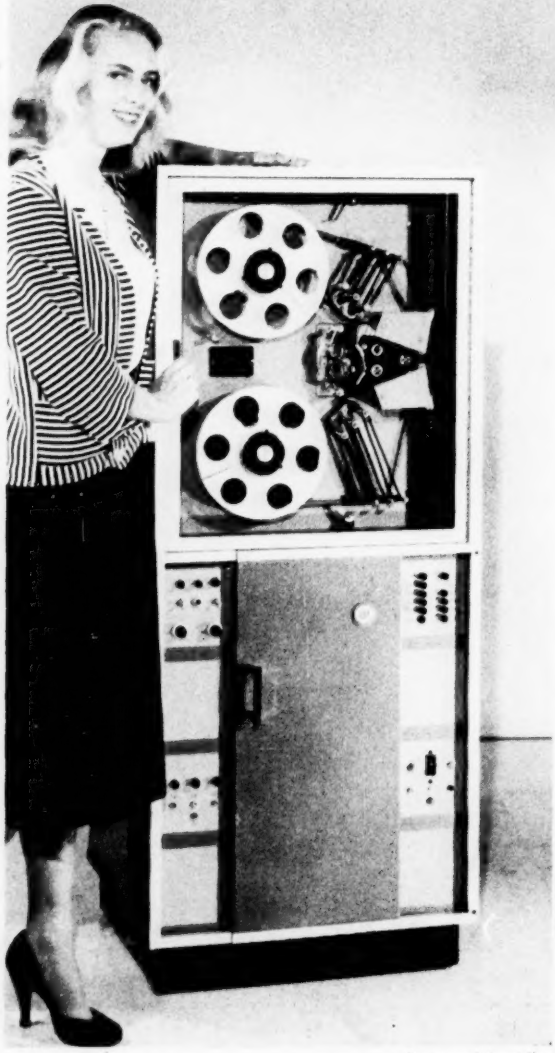
National Bureau of Standards has determined new value for fundamental physical constant, gyromagnetic ratio of the proton (measure of proton's interaction with magnetic fields). Results will be better standard for magnetic fields, more accurate values for many fundamental constants of physics, convenient standard for science and industry in measuring magnetic fields (in cyclotrons, mass spectographs, beta-ray spectrometers, servomechanisms, and electromagnets).

West German precision instruments and optical goods production declined from DM 982 million in first half of 1957 to DM 960 million in same period 1958 reports BDSA, Dept. of Commerce. Decline is 4.4% in view of price rise. (DM 4.20 = US $1)

In 1900, 15% of high-school age group were in high school (today the figure is 80%); 4% of college-age group were in college (today figure is 30%); 2% of persons of 22-year-age or older graduated college (today figure is 12%). Further the population has more than doubled since 1900. Thus American educational system has taken ever-increasing load with every-increasing success—and ever-decreasing support in terms of gross national product.

US Dept. of Labor reports that by 1965 we will need 127 clerical and sales persons for every 100 now employed; 122 management workers for every 100 now employed.

new speed in digital data processing



Encompassing the latest in packaging and reliability, Consolidated's new MicroSADIC commutates and converts up to 10,000 analog inputs per second. Outputs are recorded on digital magnetic tape in pre-selected formats compatible with most computers and peripheral equipment. Digitizing may be in either bipolar binary, bipolar binary-coded decimal, or unipolar binary-coded decimal form. Completely transistorized, the system is packaged in modular "slices" for unusual flexibility. Write for complete story in Bulletin CEC 3004-X3.

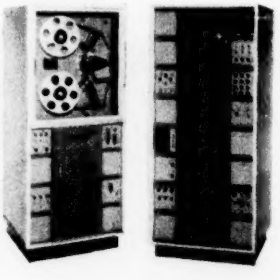
systems division **Consolidated Electrodynamics**

300 N. Sierra Madre Villa, Pasadena, California

Offices in Principal Cities Throughout the World

CEC

FOR EMPLOYMENT OPPORTUNITIES
with this progressive company, write
Director of Personnel.



The basic MicroSADIC consists of a commutator, digitizer, system programmer, time programmer, and digital tape unit. All-transistor circuitry on printed boards results in low power consumption and trouble-free operation.

For more information circle **14** on inquiry card.

New 3-Way Nylon-Body Solenoid Valve...

List Priced as Low as $10.75...

(Quantity Discounts Available)

Outlasts, Outperforms Steel!

SV-54 Series

VALCOR'S new 3-way Nylon solenoid valve, SV-54 Series, outlasts and outperforms steel, yet is list priced as low as $10.75! In general purpose and O.E.M. installations, where millions of operating cycles are essential, this new Valcor valve not only works best but costs less.

Its nylon seat outlasts steel...its port threads outlast steel . . . pound for pound it's *3 times stronger than steel.* Dry seal threads, no compound is needed—and they won't loosen even under severe vibration. Nylon is non-corrosive so you have no atmospheric problems. And the stainless plunger is a reliable workhorse for millions of cycles. Bubble tight sealing. Available in normally open, normally closed and "directional control" configurations in all normal AC and DC voltages...$1\frac{1}{2}$" square x 3" long (valve illustrated).

Write today for complete technical data on this shock-resistant, pressure-proof valve—the 3-way nylon-body valve, SV-54 Series, that's 3 times stronger than steel, yet costs less. Try it on your toughest application.

VALCOR SOLENOID VALVES

VALCOR ENGINEERING CORP.

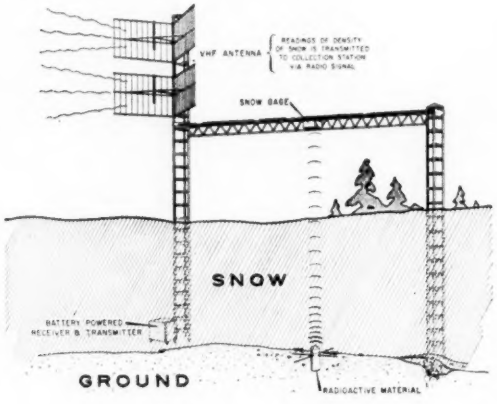
5366 Carnegie Avenue, Kenilworth, New Jersey

For more information circle **15** on inquiry card.

news

Electronic Snow Gaging

MENLO PARK, CALIF.—A new electronic-telemetering system for measuring water content of mountain snowpacks is being installed in a remote area of California's rugged Sierra Nevada mountains. The system was developed by the U. S. Army Corps of Engineers and Sierra Electronic Corporation.



The snow gauging equipment, based on a radiation detector of the scintillation type, enables engineers to obtain accurate hydrological data (water content of snow) from remote, unattended areas. Each gage site includes a scintillation radiation detector, a radio transmitter, receiver, battery and control unit. Radiation for measuring the water content of the snow is supplied by a small deposit of radioactive cobalt buried at ground level. Directly above the cobalt, at a height of 15 feet, is the radiation detector.

Melick Sworn in by U.S. as Assistant Director of BDSA

WASHINGTON, D. C.—Lawrence L. Melick, Bailey Meter Co., recently was inducted as assistant director, Scientific, Motion Picture and Photographic Products Div., Business and Defense Service Administration, U. S. Department of Commerce.

Melick, recruited by SAMA government liaison committee as the industry's representative in the Commerce Department until June 30, 1959, is shown taking the oath of office.

Several members of the SAMA liaison committee witnessed the ceremonies. They are (l. to r.) A. E. Gee, American Optical Co.; G. E. Beggs, Jr., Leeds & Northrup Co.; SAMA president R. E. Welch, Welch Mfg. Co.; A. Coors, III, Coors Porcelain Co.; and H. M. Auld, executive secretary, SAMA recorder-controller section.

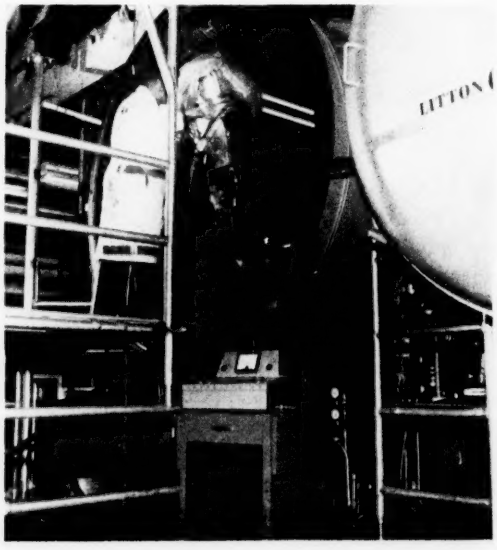
State Government Leases Computer

HARRISBURG, PA.—The Commonwealth of Pennsylvania recently opened its new UNIVAC data processing center here. Thus Pennsylvania will be the first state in the Union to have a data processing center for use by all its departments and agencies.

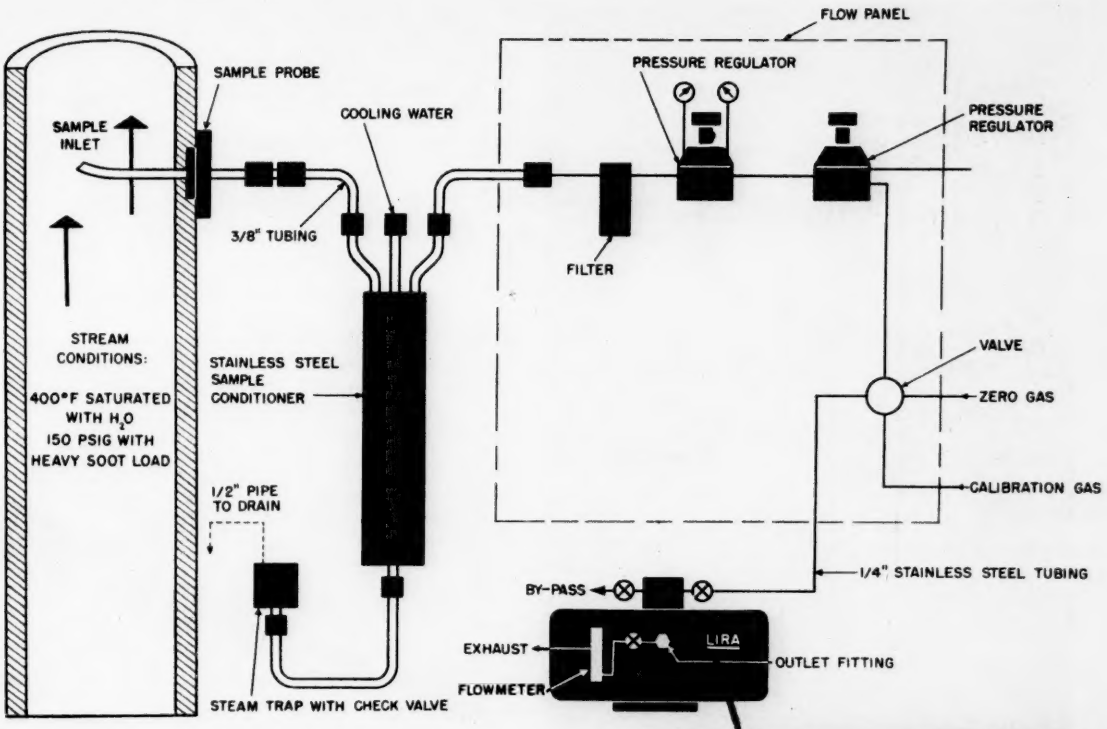
The system is leased to the Commonwealth at a monthly cost of $25,000. "If used solely for the purpose of processing the payroll it would pay for itself and still save the Commonwealth an estimated $300,000 a year," Governor Leader said.

Space Suit Provides Comfort for Scientist

BEVERLY HILLS, CALIF.—A Space Research Laboratory for evaluation studies in an atmosphere corresponding to altitudes over 100 miles has been developed by Litton Industries in cooperation with the Air Force. It also serves as an important environmental tool for subjecting equipment destined for space travel to simulated space conditions.



A protective suit encloses the scientist in a liveable atmosphere without impairing his ability to observe in detail the progress of an experiment or to make adjustments on the article under test. Every time the space suit is used it is leak tested with a Consolidated Electrodynamics helium leak detector.



Another MSA-ENGINEERED SAMPLE SYSTEM for safe, reliable gas analysis with LIRA analyzers:

sampling residual methane, carbon dioxide and carbon monoxide in synthetic ammonia plants

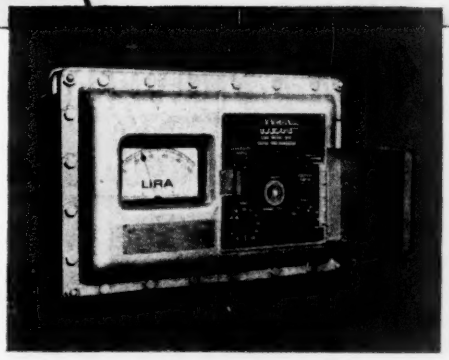
M-S-A® LIRA Infra-Red Analyzers perform two vital functions in ammonia synthesis-gas preparation facilities. They make possible instant diagnosis of operating difficulties and rapid adjustment during plant start-up. Savings involved quickly amortize the cost of the analyzer.

By monitoring methane, carbon monoxide and carbon dioxide content of hydrogen-nitrogen make-up streams, you can maintain a thorough check on gas purification operations. And the streamlined way to do it — with utmost process efficiency — is with continuous infra-red analysis. More specifically: M-S-A LIRA Analyzers.

Speaking now of applications, one of the really tough problems is analyzing the methane in the process gas immediately after the reformers. The gas stream is dirty. It is saturated with steam at high temperature and pressure. But the methane has to be measured to determine the reaction efficiency. This measurement enables the operator to adjust the process when reactor temperature or changes in the raw feed stock cause variations in methane content.

The LIRA does this measuring job to a faretheewell. Automatically. Continuously. Safely. Accurately. Inexpensively.

In the field of gas analysis — you name the gas — MSA has been coming to grips with similar process problems for over 30 years. We'd like to lay that 30 years on the line and let it work to your advantage. Ask the MSA Instrument Specialist to call. And write us for the M-S-A LIRA bulletin.

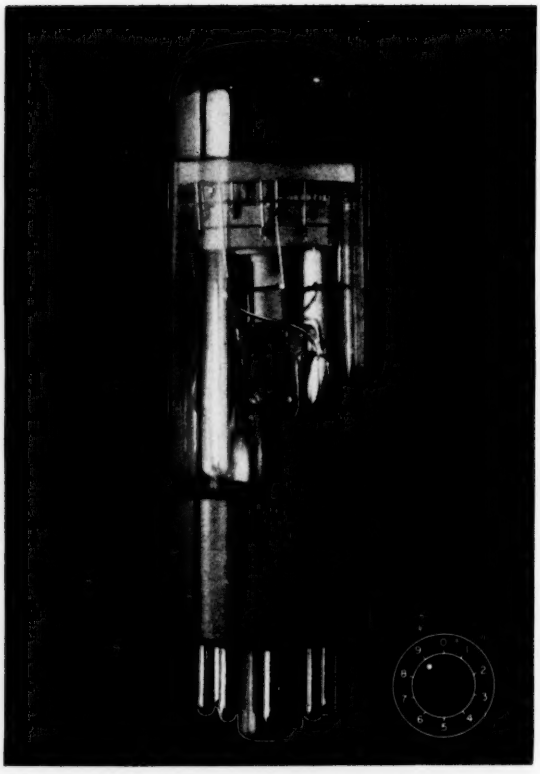


Explosion-proof Model 200 LIRA has a tamper-proof lock. All self-checking circuit controls are easily accessible through the explosion-proof enclosure.

INSTRUMENT DIVISION

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

For more information circle **16** on inquiry card.



Need a **PROVEN** tube that indicates and counts?

dekatron*

The only cold-cathode glow transfer counting tube **WITH OVER 10 YEARS OF SERVICE RELIABILITY AND PERFORMANCE.** Simple circuitry. Electronic speed and accuracy up to 20,000 counts/sec. For counting, sorting, programming, unit flow, packaging and many other applications. Continuous visual reference to total count. For detailed information, request Technical Data Sheet IC4001.

*Trademark

Baird Atomic

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33 UNIVERSITY RD., CAMBRIDGE 38, MASS.

Instrumentation for Better Analysis

For more information circle **17** on inquiry card.

NEWS—CONTINUED

EPSCO Inc. will market, through its nation-wide sales organization, the DYKOR series of high-speed photoelectric paper tape, reel and strip readers manufactured by DIGITRONICS, Inc.

THOMPSON-RAMO-WOOLDRIDGE CO. (which is marketing the nation's first digital control computer, the RW-300) has joined with Standard Oil of Ohio in a cooperative development study concerning the applications of digital computers to automatic process control.

REMINGTON RAND Division of Sperry Rand Corp. has published the first of a series of papers (UC 892) aimed at providing a broad theoretical foundation for the problem of information retrieval of electronic computers.

CHEMICAL PLANTS DIV. of Blaw-Knox Co. has installed a Royal-McBee LGP-30, stored-program, electronic digital computer, to solve computations in designing heat exchangers, power piping systems, etc., thus releasing manpower for other phases of work.

ROYAL-McBEE's LGP-30 desk-sized digital computer was chosen by Pacific Optical Corp. for optical design calculations and has reduced the time for computation "from months to minutes."

BENDIX AVIATION CORP. has developed an accessory called the CA-2 for its G-15 digital computer that gives punched-card data-processing capabilities to the computer and will lease at a low rate.

SWARTWOUT COMPANY has received a contract in excess of $200,000 to furnish the entire control equipment for Esso's new refinery at Rotterdam, Holland.

WESTINGHOUSE scientists have discovered new uranium compounds which belong to a group of substances called superconductors—materials characterized by the remarkable ability of permitting an electric current, once started in them, to flow in undiminished strength forever.

INFORMATION PROCESSING will be discussed in an **INTERNATIONAL CONFERENCE** in Paris, June 15-20, 1959. At the same time an International Exhibition of data processing equipment will be held. Information for the Conference is available from the U. S. Committee c/o I. L. Auerbach, Box 4999, Washington 8, D. C.

ELECTRONIC ASSOCIATES, INC. will continue to market its analog computing equipment and larger plotting systems through its present sales engineering staff, but will seek wider coverage of its growing line of related instruments and marketable components through an organization of manufacturers' representatives. Mr. James H. Smiley, formerly of the direct sales group, has been placed in charge of Sales Promotion Standard Instruments. Interested groups should make immediate contact with Electronic Associates, Inc., attention Mr. J. H. Smiley, Sales Promotion Standard Instruments, Long Branch, N. J.

HAGAN CHEMICALS & CONTROLS will furnish an electronic system, including magnetic amplifiers, to Carolina Power and Light Co., which will control combustion, feedwater flow, pump recirculation, and steam temperature on a new 1¼-million-lb/hr steam-generating unit.

from Skinner in '58

...these answers to your control "puzzles"

L **NEW two-way valve for high flow industrial applications**

At greatly reduced cost, this larger pilot-operated valve permits applications not possible before. Designed for air, oil, water. Features ½" orifice with ⅜" or ½" NPT ports, ¾" orifice with ¾" NPT ports, 1" orifice with 1" NPT ports. Pressure differentials: 5-150 psi. Body is naval forged brass. Diaphragm is fully supported. Available in standard and Explosionproof construction, normally open or normally closed.

A **NEW three-way valve for medium-sized cylinders**

Available normally open, normally closed, directional control and multi-directional, with 5/32" inlet and 5/32" exhaust orifices and ¼" NPT ports. Designed to control air, oil and inert gases. Handles pressures to 125 psi. Body is non-corrosive zinc. Internal parts are stainless steel.

LC **NEW two-way, low-cost, pilot-operated valve**

A smaller, lighter, normally closed valve. Permits full flow through ½" orifice with ⅜" or ½" NPT ports. Will control all common media: air, oil, water, etc. Pressure differentials: 5-150 psi. Forged naval brass body. Uniquely designed diaphragm – fully supported.

R **NEW two-way valve for standard and high pressure applications**

A big capacity, pilot-operated valve with a ¼" orifice and ¼" NPT ports. Designed to control air, water, oil, semi-corrosive materials. Long-lasting, stainless steel internal parts. Forged naval brass body. Available normally open or normally closed. Standard models operate on pressure differentials of 5-200 psi; high pressure normally closed models on 5-1250 psi.

For complete information, please contact our Representative or Distributor near you . . . you'll find him listed in the yellow pages or write us at the address below, Department 41N

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
144 EDGEWOOD AVENUE

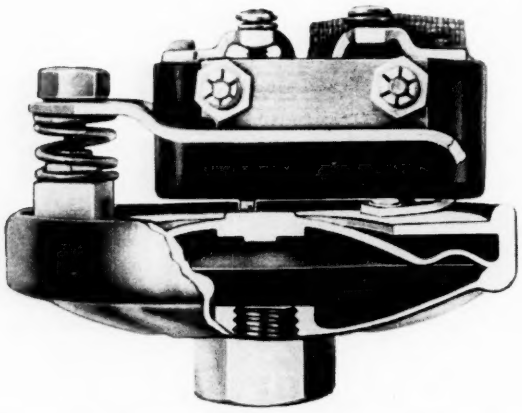
THE CREST OF QUALITY

For more information circle **18** on inquiry card.

NEW PRESSURE SWITCH FOR THE O.E.M.

This *stripped* switch is designed specifically for the Original Equipment Manufacturers who enclose the various controls in a common cabinet. This new pressure and vacuum switch model 402, incorporates the same dependable accuracy and other operating features of the proven *housed* model 420.

Cost and price have been cut by eliminating the housing.



HERE'S THE SIMPLEST DIAPHRAGM PRESSURE SWITCH

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during entire operating life due to direct acting design.	LINKAGE and BEARINGS because wear causes the setting of the pressure switch to drift.
EFFICIENT OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch using liquid switching elements.	LIQUID SWITCHING ELEMENTS because they make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION allowing the switch to be mounted directly on any vibrating or moving equipment.	ACCORDION BELLOWS because they make the pressure switch sensitive to vibration.

To get complete specifications and operating data ask for bulletin 402.

PRESSURE SWITCH DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

For more information circle **19** on inquiry card.

stock report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

American Stock Exchange:

AMERICAN STOCK EXCHANGE
Price Range for 1958 thru 10/15/58

	HIGH	LOW	PRICE AS OF 10/15/58
American Meter	37	27 5/8	30 1/2
Arc Equipment	21 1/2	13 3/4	20 1/8
Barry Controls "B"	10 7/8	4 3/8	9
Belock Instruments	12 3/4	7 3/8	10 5/8
Benrus Watch	6 7/8	4 7/8	6 1/4
Breeze Corp.	7 1/8	5 1/8	6 3/4
Clark Controller	21 1/2	14 7/8	21
Clarostat M.g.	4 3/8	2 7/8	3 5/8
Clar Corp.	5	2 7/8	4 1/4
Du-Mont Laboratories	5 3/8	3	4
Dynamics Corp. of America	4 1/2	2 1/8	4
Electronics Corp. of America	12 7/8	9 1/8	10 1/2
El-Tronics	3 1/8	1 3/8	2 3/8
Fairchild Camera & Instrument	32 3/4	17 1/2	30
Globe-Union	17 1/4	14 5/8	16 5/8-17 (1)
Hazeltine Corp.	49 1/2	30 1/2	44 1/8
International Resistance	7 7/8	3 3/4	5 3/4
Lear, Inc.	5 1/2	4 1/4	4 1/2
National Research	17 3/8	12 7/8	14 5/8
Neptune Meter	31	17 1/8	24 1/8
New Haven Clock	2 1/4	7/8	1
Norden-Ketay	5 7/8	2 3/4	5
Nuclear Corp. of America	1 1/2	7/8	1 3/8
Pneumatic Scale	30	16 1/2	31-33 1/4 (1)
Servo Corp. of America	9 7/8	3 1/4	8 1/4
Servomechanisms	11 1/8	5 5/8	8 3/4
Wallace & Tiernan	33 3/4	24	30 7/8
Waltham Prec. Instrument Co.	1 1/2	13/16	1

(1) Not Traded - Bid and Asked

New York Stock Exchange:

NEW YORK STOCK EXCHANGE
Price Range For 1958 thru 10/15/58

	HIGH	LOW	Price as of 10/15/58
AC F Industries	44 1/2	37 1/8	42 1/4
Aeroquip Corp.	21 7/8	16 7/8	19
Allis Chalmers	29 3/4	22 1/8	27 5/8
American Chain & Cable	51	39 1/2	48 5/8
American Machine & Foundry	50 3/4	38 1/4	47 3/8
American Machine & Metals	63 1/2	47 1/2	62
American Optical	39 1/8	34 3/4	36 7/8
American Tel. & Tel.	195 1/2	167 7/8	193 3/4
Beckman Instruments	30	18 1/8	29 5/8
Bell & Howell	79 3/4	42	75 1/4
Bendix Aviation	61 3/8	44 1/2	55
Boeing Airplane	50 3/8	34 1/8	49 7/8
Bullard	18 1/2	10	17 1/8
Bulova Watch	14	9 3/4	13
Burroughs	40 1/2	27 5/8	37 1/2
Carborundum	39 3/8	30 7/8	36 3/4
Cincinnati Milling Machine	44 1/2	27	43 1/8
Clevite	21 1/2	15 3/4	20 1/4
Columbia Broadcasting "A"	39 3/8	24 1/2	37 1/2
Consolidated Electrodynamics	37 1/2	27 7/8	35 3/8
Consolidated Electronics	27 7/8	19 1/2	27
Cornel Dubilier	18 3/4	12 3/4	18
Corning Glass	95	74 5/8	87
Curtiss-Wright	32 1/2	20 5/8	27 1/2
Cutler-Hammer	59	46 1/2	56 1/4
Daystrom	39 1/4	30	30
Douglas Aircraft	74 7/8	54 1/2	58 1/2
Eastman Kodak	131	97 1/8	129 1/2
Eaton Manufacturing	59	38 1/2	56 5/8
Electric Auto Lite	37 1/8	25	35 5/8
Elgin Watch	9 3/4	6 3/4	8 7/8
Emerson Electric	44 3/4	29	43
Food Machinery & Chemical	70 5/8	47 1/2	68 1/4
Gamewell	32 1/8	20 1/2	30 1/2
Garrett	44 1/2	27	39 5/8
General Controls	21 3/8	14	20 1/4
General Dynamics	65 3/4	55	57 1/2
General Electric	68 3/4	57	66 1/2
General Instrument	11 3/8	4 5/8	10 1/4
General Mills	85 7/8	60 1/4	84 1/4
General Precision Equipment	41	27	30 1/2
General Railway Signal	32 7/8	21 1/8	30 3/4
General Telephone	53 3/8	40 3/8	52 5/8
General Time	25 1/2	16 5/8	24 1/4
General Tire & Rubber	30	22 1/4	26 1/4
International Business Machines	454 1/2	300	435
International Tel. & Tel.	49 1/4	29 1/4	48 1/2
I-T-E Circuit	42 1/4	36 1/8	40 5/8
Litton Industries	74 1/8	36 7/8	72 1/4
Lockheed Aircraft	54 3/4	37 3/8	50 5/8
Magnavox	42 1/4	30 1/4	38
Mallory	34 1/4	23 5/8	30 3/4
Minneapolis-Honeywell	101 1/2	76	97
Minneapolis Mining & Mfg.	97 3/4	73 1/2	93
Motorola	49 1/2	35	48
National Acme	59 1/4	43 7/8	59
National Cash Register	76 3/4	50 1/2	74 1/2
North American Aviation	36 7/8	25 5/8	32 7/8
Northrop Aircraft	29	22 1/8	27 3/8
Otis Elevator	59 ½	40 1/4	57 1/2

Continued on page 1764

FOR UNVARYING PERFORMANCE

PRECIOUS METAL CONTACTS . . . for long operating life and unvarying performance. Available in pure or alloyed forms of Silver, Platinum, Palladium, and Gold. These contacts provide extremely high resistance to atmospheric corrosion, deformation, arc erosion, sticking and metal transfer. They are supplied as wire, rod, sheet, and as fabricated forms.

Baker Contact Division, 207 Grant Avenue, East Newark, Harrison P. O., N. J.

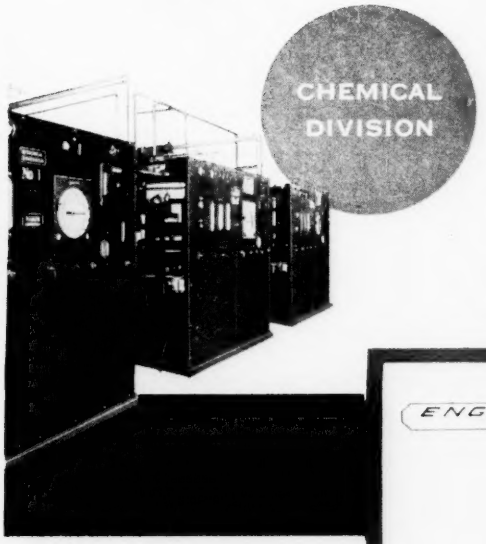
For more information on Contacts circle **20** on inquiry card.

FOR CORROSION-RESISTANT SURFACES

RHODIUM PLATING . . . an economical, hard, white, corrosion-resistant surface. Extremely well-suited for many electrical and electronic applications. Resistant to corrosive atmospheres, oxidation, arc erosion. Reduces wear on moving surfaces, assures low noise level for moving contacts, no oxide rectification, low and stable contact resistance. Ideal when a low-resistance, long wearing, oxide-free contact is required.

Chemical Division, 113 Astor Street, Newark 2, N. J.

For more information on Rhodium Plating circle **90** on inquiry card.



FOR PRODUCING NITROGEN

NITRONEAL® GAS GENERATOR . . . With a controllable hydrogen content—produces oxygen-free gas consisting of nitrogen, hydrogen and water vapor. Hydrogen content can be varied and maintained as desired between 0.5% and 25%. Economy is a major factor in this equipment. The cost of the nitrogen produced is found to be many times cheaper than an equal amount of cylinder nitrogen. Furthermore, the catalyst lasts indefinitely—maintenance costs are practically nil.

Chemical Division, 113 Astor Street, Newark 2, N. J.

For more information on Gas Generators circle **91** on inquiry card.

ENGELHARD INDUSTRIES, INC.

113 ASTOR STREET
NEWARK 2, NEW JERSEY

READ

any surface temperature

with *Alnor* PYROCON

Equipment...material...metallic or non-metallic...flat, curved... revolving or stationary—you can read every surface temperature accurately in less than 3 seconds!

Compact, complete in precision design, this rugged instrument assures highest standards of speed, accuracy and dependability.

Alnor Portable Pyrocons come in scale ranges to 2000° F., with thermocouples for every application. You'll find full details on the Pyrocon exactly suited to your operations in Bulletin 4257. Send for your copy now. Write: Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

Alnor PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **21** on inquiry card.

New York Stock Exchange: *Continued from page 1762*

Philco Corp.	23 1/4	12 3/8	21 7/8
Radio Corp. of America	41 3/4	30 1/4	39
Raytheon	49	21 1/2	47 3/8
Reliance Electric	48 1/8	31	48
Rheem Mfg.	15 5/8	10 1/2	14 1/4
Robertshaw-Fulton	29 1/4	22 1/4	28 1/4
Royal McBee	25 1/4	16	22 5/8
Sangamo Electric	34 3/4	25	27 1/8
Sperry Rand	22 1/2	17 3/4	20 3/4
Square D.	27 1/2	20 1/8	25 5/8
Standard Coil Products	10 3/8	5	9 1/2
Starrett (L.S.)	74 3/4	57	64
Stewart-Warner	40 5/8	29	40
Sylvania Electric	49	31 1/2	44 3/8
Telautograph	6 3/8	3 1/4	3 3/4
Texas Instruments	54 3/8	28 3/4	51 7/8
Thompson Products	61 5/8	41 3/8	59
Tung-Sol Electric	29 1/4	23 1/4	28 5/8
Underwood Corp.	22	12 7/8	14 1/8
Union Carbide Corp.	116 1/2	83 7/8	113 1/4
United Shoe Machinery	47 7/8	32	43
Western Union	21 1/2	14	20 3/8
Westinghouse Air Brake	27 1/4	17 7/8	27 3/8
Westinghouse Electric	78 1/4	55 1/2	74 1/4
Worthington Corp.	46 1/4	46 1/4	44 1/4

Over-The-Counter

QUOTATION AS OF 10/15/58

	BID	ASKED
Aerovox Corp.	4 3/4	5 1/4
Aircraft Radio Corp.	25 1/4	26 1/2
Argus corp.	27 3/4	28 3/4
Eitel-Mc Cullough	24	25
Electronics Associates	37 1/2	40
Erie Resistor Corp.	7 7/8	8 1/4
Fisher Governor Company	17	17 5/8
Foxboro Company	41 3/4	43 1/4
G. M. Giannini	19 1/2	20 1/4
Industro Transistor	2 1/4	2 5/8
Liquidometer Corp.	5 3/4	6 1/4
R. I. Maxson	6 1/2	7
Penn Controls, Inc.	17	-
Speer Carbon, Inc.	27 1/4	28 1/2
Sprague Electric	34 1/4	35 1/2
Taylor Instrument	31 3/4	32 3/4
Telecomputing Corp.	5 1/4	5 1/2
Topp Industries	7 3/4	8 1/8
Varian Associates	28 5/8	29 1/8
Vitro Corp. of America	14 5/8	15 3/8

EQUIP FOR THE SIZE OF THE JOB

USE THE PERFECT COMBINATION

For Assured Accuracy

in MICRO-DRILLING

SPHINX

HIGH SPEED STEEL MICRO-DRILLS

Drills from .0016" to .0591" are stocked in increments of .0004"(.01 mm). From.0610" to .1181" in increments of .0020" (.05 mm). Left hand micro-drills for use on Swiss type automatic screw machines. Short flute center drills. Send for Bulletin "Q" listing complete line of drills or Catalog M listing collets as well as full line of instrument lathes and accessories.

Louis Levin & Son, Inc., 3610 S. Broadway, Los Angeles 7, California.

LEVIN ®

SUPER PRECISION COLLETS

Super precision collets for jewelers type lathes. Ideal for holding micro-drills or other parts where concentricity is important. Available from stock in complete range of sizes from .004" (.1 mm) to 5/16" (8.0 mm).

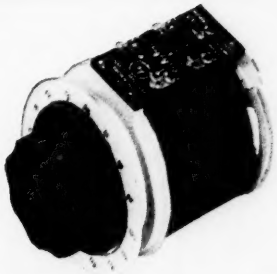
For more information on Micro-Drills circle **22** on inquiry card.
For more information on Collets circle **92** on inquiry card.

Now — 3 New

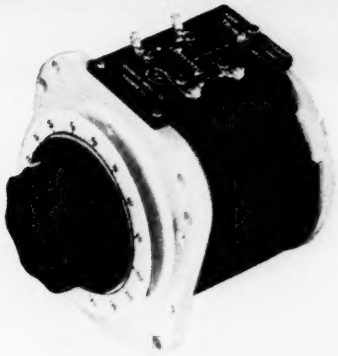
OHMITE® V.T. Variable Transformers

Enclosures . . . Tandem Assemblies

Model VT2—1.5 Amp. Max. Output Current at any Contact Setting (120 V. Input). Load Rating: 0.20 Kva. Angle of Rotation: 320°. Standard Mounting: For panels up to ¼", by ⅜"-32 Bushing and Nut. Weight: 2.5 lb. Pat. No. 2,790,882.



Model VT4—3.5 Amp. Max. Output Current at any Contact Setting (120 V. Input). Load Rating: 0.49 Kva. Angle of Rotation: 324°. Standard Mounting: Table mounting or for panels up to ⅜", by 3 screws ¼"-20 (or 4 screws with Adapter Plate). Weight: 5.25 lb.



Model VT8—7.5 Amp. Max. Output Current at any Contact Setting (120 V. Input). Load Rating: 1.0 Kva. Angle of Rotation: 324°. Standard Mounting: Table mounting or for panels up to ⅜", by 3 or 4 screws ¼"-20. Weight: 10.25 lb.

Industry's Most Advanced Design! Ohmite VT continuously adjustable autotransformers provide convenient, smooth, wide-range voltage control for alternating current power circuits. Units deliver adjustable voltage, continuously variable from zero to (a) line voltage or to (b) 10% or 17% above the primary line voltage — provide excellent voltage regulation — voltage remains practically constant at any setting, regardless of load fluctuations.

Model VT2 has higher current and kva capacity than equivalent size transformers. Current is carried from contact brush to a copper-graphite slip-ring. A coil spring provides uniform pressure at this point; a long, spring-steel arm, insulated by a ceramic hub, provides pressure for the carbon contact. Positive internal stops eliminate possibility of damage to contact arm and brush due to application of torque at rotation limits.

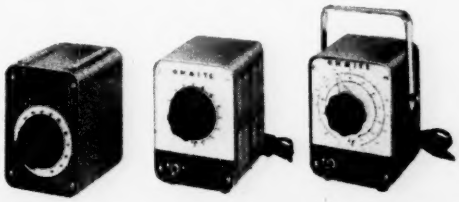
Model VT4, like the VT2, has higher current and kva capacity than equivalent size transformers. A low resistance path is assured by a pigtail directly connected from contact brush to the "slip-ring." Contact heat is efficiently dissipated by the circular contact carrier plate.

Tapped holes in the plate provide for 3-hole mounting. The mounting holes in the base plate, or in separate adapter plate (when specified), provide for 3- or 4-hole mounting interchangeable with other similar transformers. The contact brush is readily accessible for service or replacement. The insulated shaft can be conveniently adjusted for either table or back-of-panel mounting.

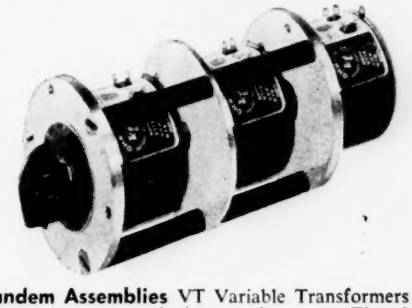
Model VT8 possesses all the features of the VT4 and has a unique base plate which permits 3- or 4-hole mounting interchangeable with other standard types.

Transformers can be provided with shafts of special length, with rear extension, special flats, etc. Bushings for VT2 can be made for special panel thicknesses. A "Micro-Switch" or similarly sensitive switch can be provided mounted on the transformer. VT Transformers can be provided with a motor drive for remote control or servo operation.

Write on company letterhead for new Catalog and Engineering Manual 58.



Enclosures can be provided for portable or fixed use (back-of-panel or surface mounting). Portable housings may have a line cord, a receptacle, pilot light, fuse, or circuit breaker as specified.

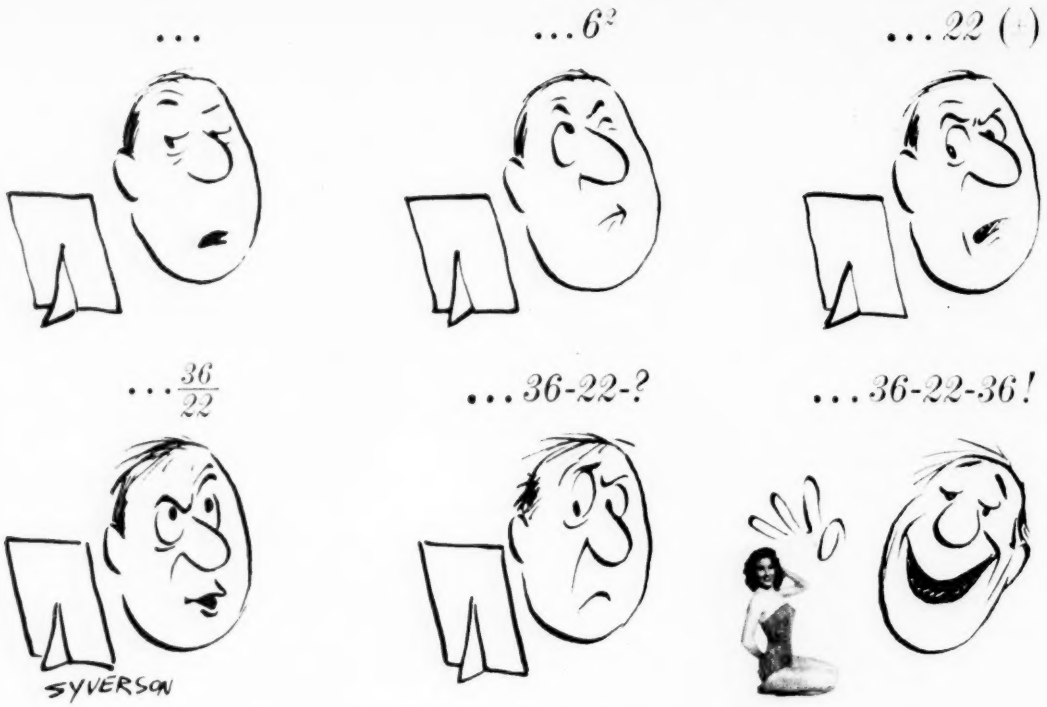


Tandem Assemblies VT Variable Transformers are ganged by means of plates and spacers. The shafts are joined by special couplings for Model VT2; a throughshaft is used for VT4 and VT8. Special tandem assemblies of VT Transformers and Ohmite Rheostats can be made as required.

OHMITE MANUFACTURING COMPANY
3615 HOWARD STREET
SKOKIE, ILLINOIS

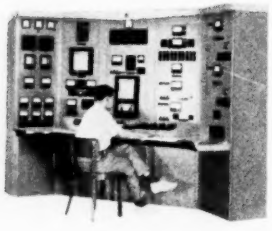
RHEOSTATS RESISTORS RELAYS TAP SWITCHES R.F. CHOKES VARIABLE TRANSFORMERS TANTALUM CAPACITORS

For more information circle **23** on inquiry card.



What's the size of your design problem? Facing a multiplicity of project details? It's no laughing matter when you're caught short-handed on a critical design program. You need proved engineering ability **plus** systems capabilities you can count on. Next time... **this** time—

LOOK TO INET FOR UNIQUE DESIGN CAPABILITIES



Here's another example of INET capability: the console, recorders and related instruments built, installed and wired by INET for Atomics International's L-54 nuclear research reactor. The solution-type L-54 reactor, which has a rated power capacity of 5,000 watts, was designed and built by Atomics International for the West Berlin Institute for Nuclear Research. It is being used for German scientific, medical and industrial research.

Engineers desiring a special reprint of the cartoon above should write to "36-22-36," c/o Inet Division, Leach Corporation.

INET DIVISION LEACH CORPORATION

18435 SUSANA ROAD, COMPTON, CALIFORNIA

DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA
EXPORT: LEACH CORPORATION, INTERNATIONAL DIVISION

For more information circle **24** on inquiry card.

Circle **25** on inquiry card. →

INTER-RUPTED!

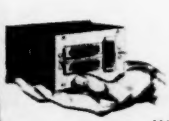
if a priceless audience switches channels

This situation has happened all too often in the past. But now it seldom occurs, because most of the vast transmission and control networks are designed on a modular basis.

Circuitry is arranged so that essential elements or sub-assemblies can be disconnected quickly . . . and spare parts inserted . . . while parts in trouble are checked when convenient.

How about your system or product? Do your customers encounter loss of time, loss of equipment use, loss of production because of hard-to-follow wiring or transference of control elements? Perhaps the reliability of your products could be improved through the use of Cannon Plugs modular units. Cannon makes **over 27,000** different plugs—can engineer them to meet your requirements in modular "black-box" unit assemblies to minimize interruptions and make it possible to correct them, if they should occur, in a matter of seconds. Cannon will design and make the plugs and assemblies you need. Write today for brochure "The Modular Concept" which explains how modular designs can save dollars. Please refer to Dept. 419

Cannon Electric Company, 3208 Humboldt Street, Los Angeles 31, California.



CANNON PLUGS

Where Reliability for Your Product is Our Constant Goal

CANNON ELECTRIC

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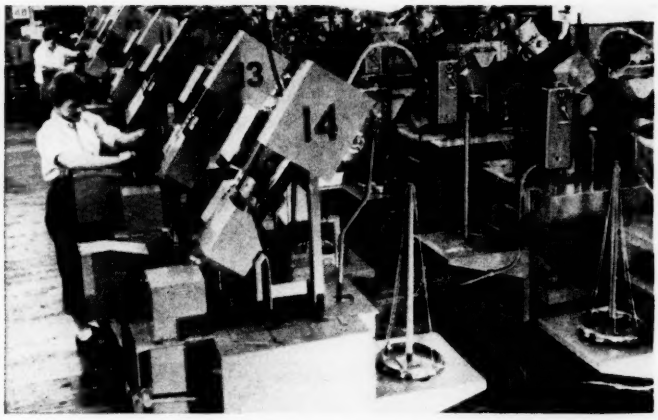
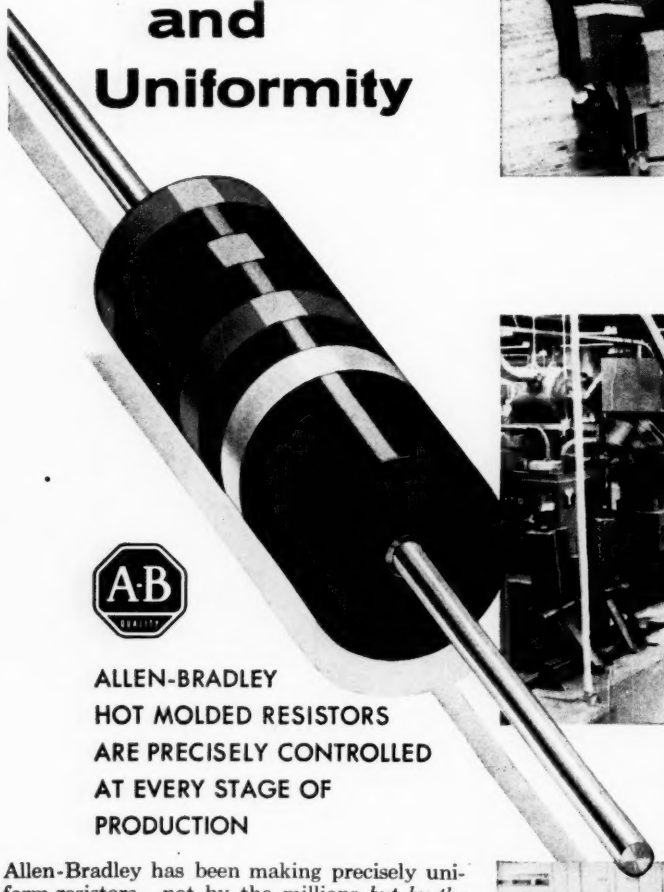
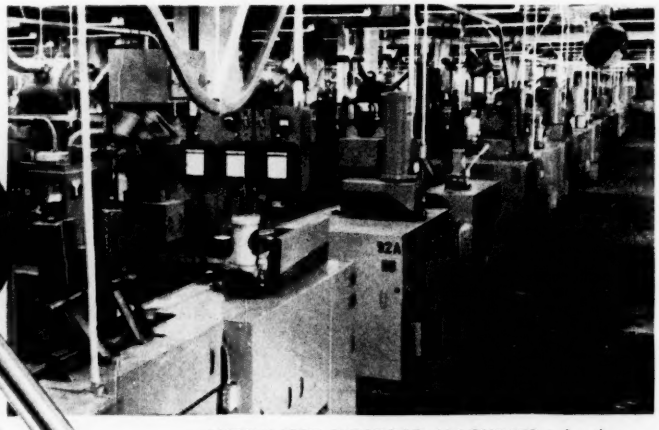
Miracle of Precision and Uniformity



AUTOMATIC HEADING MACHINES form heads on the end of lead wires to make sure they will be solidly anchored in the resistor body. Wire has been previously tinned for easy soldering.





AUTOMATIC MOLDING MACHINES take the resistance powder, insulation powder, and lead wires, and hot mold them under closely controlled high temperature into one integral unit.

ALLEN-BRADLEY HOT MOLDED RESISTORS ARE PRECISELY CONTROLLED AT EVERY STAGE OF PRODUCTION

Allen-Bradley has been making precisely uniform resistors — not by the millions *but by the billions* — over the years. The *exclusive* hot molding process — developed and perfected by Allen-Bradley — uses specially designed automatic machines that incorporate precision control at *every* step of production. Shown here are a few of the special machines that make possible the amazing uniformity — from resistor to resistor, year after year — for which Allen-Bradley composition resistors are famous.

AUTOMATIC COLOR CODING MACHINES apply color bands and oven-bake the enamel at high temperatures to assure that the color coding will withstand the maximum operating temperatures of 150°C and all types of cleaning solvents.

Allen-Bradley Co., 140 W. Greenfield Ave.
Milwaukee 4, Wisconsin

In Canada: Allen-Bradley Canada Ltd.
Galt, Ontario

ALLEN-BRADLEY
QUALITY

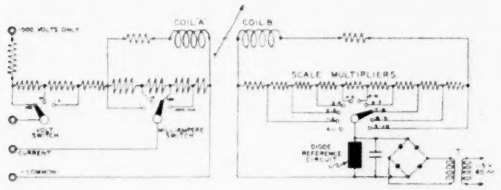
Electronic Components

For more information circle **26** on inquiry card.

briefs

Differential Incremeter

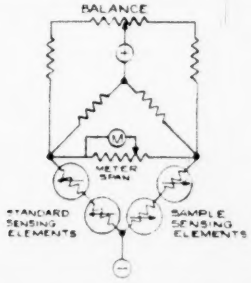
Differential instruments have been used for high accuracy comparisons for many years. Now . . . we have combined differential instrument "high comparative accuracy" with a "high-accuracy" stable reference source and produced a 63-inch scale instrument with 0.1% accuracy. The Differential Incremeter has a 6.3 inch scale. However, the addition of an expansion circuit allows this 6.3 inch scale to be effectively spread out to ten times its own length. This is accomplished by making it read in successive positions: Zero to 0.1 full scale, 0.1 to 0.2 of full scale, 0.3 to 0.4 of full scale, etc. . . . Coil "A" of a differential movement is furnished with the usual shunts and series resistance for current and voltage measurements. Coil "B" is supplied from a high accuracy regulated supply with currents to provide a suppression of up to 90% of the full scale value . . . (*From new 2-page specification sheet, Sensitive Research Instrument Corp., New Rochelle, N. Y.*)



For this literature circle **155** on inquiry card.

Therma Bridge Gas Analyzer

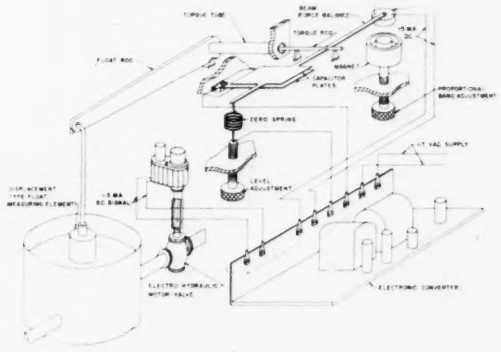
The theory of determining gas purity percentages by thermal conductivity is based on the well-known facts that each specific gas has an individual heat transmission factor and that certain metals have a fixed temperature-resistance relationship. A Wheatstone Bridge circuit in which one arm is used as a standard or reference sensing element with a second arm used as a sample sensing element is the heart of the system. With a suitable electric current flowing through the bridge and the same gas or gas mixture surrounding each sensing element, equal resistances are developed. However, if a different gas or gas mixture is introduced around the sample sensing element, this element will be cooled or heated to a new temperature with a consequent change in the resistance of this arm . . . (*From new 6-page bulletin Industrial Instruments Engineering Corp., 89 Commerce Rd., Cedar Grove, Essex County, N. J.*)



For this literature circle **156** on inquiry card.

Electronic Level-Trol

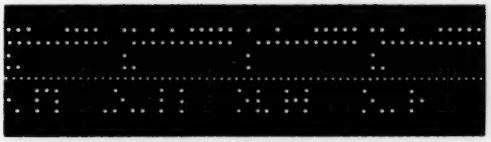
The measuring element is the displacer float of the standard Level-Trol assembly . . . In the Electronic Level-Trol, a movable capacitor plate is connected to the torque rod so that any rotary motion of the torque rod will position the movable plate with respect to a fixed capacitor plate. These plates are the sensing element of the control loop . . . The feedback coil beam connects the force motor coil, which is surrounded by a permanent magnet assembly, to the torque rod. The dc output current from the converter goes through this coil . . . The force motor coil, in conjunction with the permanent magnet, form the feedback and force balancing element of the controller, insuring stable and accurate response to a change in liquid level . . . (*From new 4-page Bulletin F-85, Fisher Governor Co., Marshalltown, Iowa*)



For this literature circle **157** on inquiry card.

Photoreader

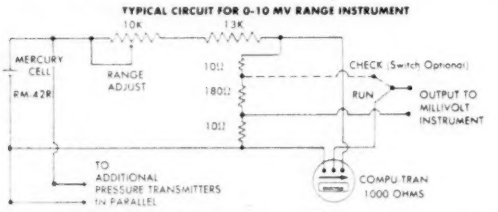
The Model 58187 is a capstan drive, reel type machine which reads perforated paper tape photoelectrically at the very high rate of 1,000 characters per second . . . A new concept in buffer-loop storage, the "parallelogram" swinging arm, provides optimum tape guidance and enables packaging in a minimum-size panel assembly . . . Special molded plastic reels have been developed for use with the Model 58187. Their low cost makes it economical to store tape directly on the reels eliminating the necessity for storage transfer . . . (*From new 4-page Bulletin 5600, Burroughs Corp., Electrodata Div., Pasadena, Calif.*)



For this literature circle **158** on inquiry card.

Pressure Transmitter

Compu-Tran pneumatic transmitters are pressure pick-ups used to convert fluid pressure inputs to exact proportional electrical equivalents. Output is in the form of precision resistance proportional to the input pressure. The signal may be of high enough level to be used in control, telemetering, or remote recording

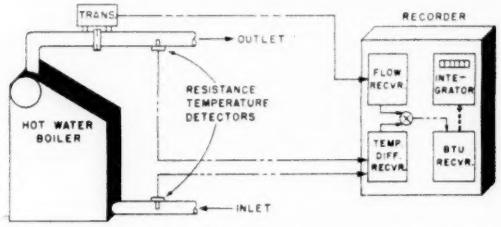


circuits without amplification . . . The pressure sensing element for the higher ranges is a specially designed Bourdon tube selected for superior linearity and hysteresis characteristics . . . The lower range pressure sensing element is a precision Ni-Span C capsule having excellent hysteresis characteristics . . . For applications involving pressure measurement of corrosive media, special models are available using appropriate materials . . . (*From new 4-page Bulletin R-1a, International Resistance Co., 401 N. Broad St., Phila. 8, Pa.*)

For this literature circle **159** on inquiry card.

Model 913 BTU Meter

The components which make up the Model 913 BTU measuring system are: One Model 771.3 Universal Recorder (Recording liquid flow, liquid differential temperature, BTU, integrating BTU); one Model 245 Differential Pressure (Flow) Transmitter; and two platinum resistance temperature elements,

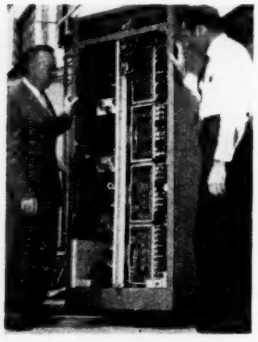


differential connected . . . Temperature of the liquid as it enters the process (heat exchanger) is measured by one resistance temperature element. The other element measures liquid temperature leaving the process . . . Liquid flow through the process is measured by the Model 245 Flow Transmitter . . . The differential temperature and flow retransmitting slidewires are connected so as to multiply their respective signals. This product (times the specific heat factor of the liquid) represents the number of BTUs gained or lost per unit of time by the liquid as it passes through the process . . . (*From new 2-page Publication 58-B913, The Hays Corp., Michigan City, Ind.*)

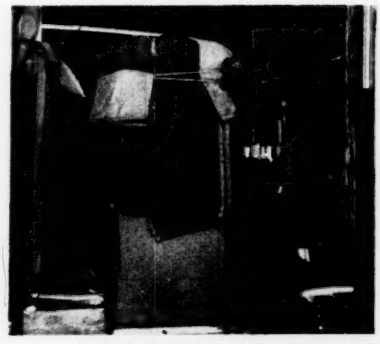
For this literature circle **160** on inquiry card.

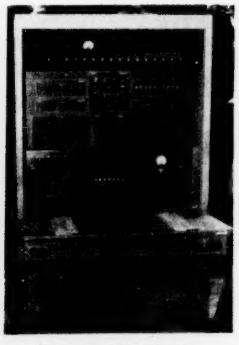
save time and money... ship via

$1,000,000 REMINGTON RAND UNIVAC TRAVELS 2,500 MILES—UNCRATED!

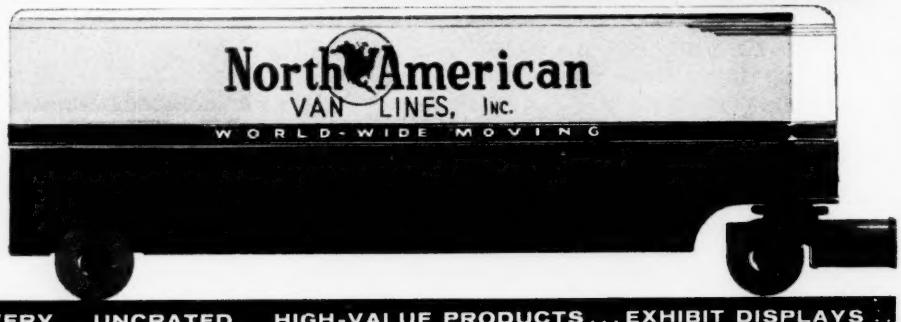


From Remington Rand's Univac Division at St. Paul, a 30-ton "electronic brain" was shipped in three big North American Vans to Bethesda, Md., then to Dallas, Texas, without major disassembly and without damage. (Left) rear view of one component part showing intricate wiring; (first right) operator's control panel, padded and anchored for smooth trip; (far right) front view of panel. Developed by North American, this method of handling delicate products eliminates crating, gets units into operation at big saving of time!





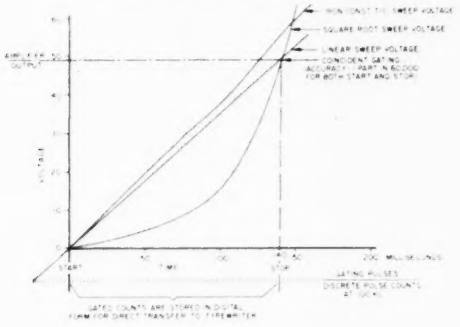
"America on the Go" Hear Alex Dreier's Salutes to Industry—Every Sunday Evening, 6:05 P.M. New York Time, NBC-Monitor



DOOR-TO-DOOR DELIVERY . . . UNCRATED . . . HIGH-VALUE PRODUCTS . . . EXHIBIT DISPLAYS . .

Electronic Data Systems

One of the most difficult functions of a logging system is the accurate linearization of non-linear inputs such as those received from flow transducers and the various types of thermocouples. The conventional use of diodes in linearizing circuits has been eliminated in the Kybernetes Systems. The contact potential problem which necessitates hand picking, and the aging effect which causes the contact potential to change, place these devices in a marginal category. To eliminate these problems a specially developed technique is employed whereby the sweep voltages produced by the voltage generator are characterized to conform exactly to the individual non-linear characteristics of the different types of variables. This is unique in the Kybernetes System and constitutes a superior method of linearization. (*From new 4-page Bulletin MSP-154. Kybernetes, Div. of Hagan Chemicals & Controls, Inc., P. O. Box 1346, Pittsburgh 30, Pa.*)



Graphic description of the analog to digital conversion and linearization operations.

For this literature circle **161** on inquiry card.

R-S Butterfly Valves

The streamlined valve disc creates a Venturi action in the open position. Compared to many other types of valves, its lower pressure drop saves pumping power.

Beveled discs seat firmly against the body when fully closed. Accurate machining and the 12½° angle of closing reduce leakage to a minimum with metal-to-metal seats. Drip-tight or bubble-tight closure can be obtained with a rubber seat . . .

Power-controlled prime movers, delivering the necessary foot-pounds of torque, open or close the valve at any desired speed . . . The flow simulates a straight line, semi-log characteristic. Cam-driven positioners can furnish other characteristics as required . . .

Design eliminates pockets which capture sediment. There is no change of flow-direction to create turbulence, thus reducing erosion and cavitation and lengthening valve life . . . (*From new 24-page Catalog 160, S. Morgan Smith Co., York, Penna.*)

For this literature circle **162** on inquiry card.

North American Van – UNCRATED!

DOUBLE-CHECK THESE ADVANTAGES:

- **Eliminates costly crating, uncrating.**
- **Saves disassembly and reassembly time.**
- **Door-to-door delivery; no drayage cost.**
- **Proved gentlest in Impact-O-Graph tests.***
- **Prompt pickup, fastest service anywhere.**

Phone your local North American Van Lines Agent now . . .

He's listed in the Yellow Pages under "Movers." Or send coupon below for details of High-Value Products and other North American specialized industrial services, and "Wife-Approved" moves for transferred personnel. North American Van Lines, Inc., World Headquarters, Fort Wayne, Ind., North American Van Lines Canada, Ltd., Pickering, Ont.

*Impact-O-Graphs placed with products shipped via North American van showed far less shock and jar than other methods of transportation. Coupon brings report of findings.

Clip this Coupon!

North American VAN LINES, Inc. WORLD-WIDE MOVING

North American Van Lines, Inc.
World Headquarters, Dept. IA-118
Ft. Wayne 1, Ind.

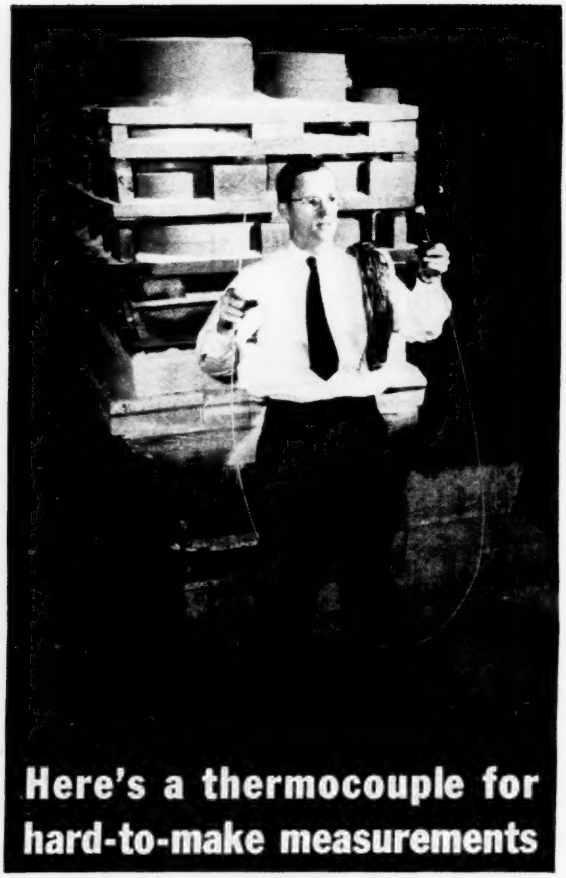
Without obligation send me the report on Impact-O-Graph tests and booklets indicated below.

☐ Exhibit Displays ☐ High-Value Products
☐ Transferred Personnel ☐ New Products Service

Name.....
Company.....
Address.....
City..... Zone..... State.....

. . RELOCATED OFFICES AND LABORATORIES

For more information circle **27** on inquiry card.



Here's a thermocouple for hard-to-make measurements

BRISTOL "Armorox" thermocouple, here about to be installed in tunnel kiln truck, is more flexible and smaller, but more rugged, than conventional thermocouples.

The Bristol "Armorox" thermocouple now makes difficult temperature measurements easy.

Good for temperatures up to 2000°F. and at pressures to 50,000 psi, the "Armorox" thermocouple is metal-sheathed, ceramic-insulated and *flexible*—easily bent around twice its own diameter to get into out-of-the-way places. What's more, no additional protecting tube is required.

The entire line of Bristol pencil-type thermocouples is offered in "Armorox" metal-sheathed ceramic-insulated construction as well as conventional construction. *Metal-sheathed construction plus tightly packed refractory insulation now permits use of smaller gauge wire than ever before at higher temperatures.* Wire sizes as small as #30 AWG give outstanding service in the advanced construction.

Sheathing available in stainless steel and Inconel*—other metals available for special applications. Diameters from 1/16 to 1/4 inch. Lengths up to 30 ft. Thermocouples available in Chromel-Alumel†, iron-constantan, copper-constantan, and other materials. Can be used for every application of conventional pencil-type thermocouples. Meet the ISA standards for accuracy.

Write for complete data on this Bristol development in pyrometry. The Bristol Company, 154 Bristol Road, Waterbury 20, Conn. B.15

*T. M. Reg. by International Nickel Co.
†T. M. Reg. by Hoskins Manufacturing Co.

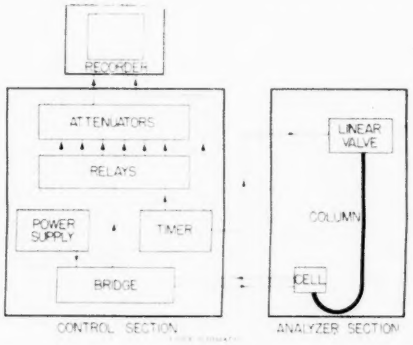
BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **28** on inquiry card.

Chroma-Cat Chromatographic Process Stream Analyzer

The chromatographic principle is used to separate the individual components in the gas stream, and a catalytic combustion cell determines their relative concentration. Use of the catalytic combustion cell in a chromatographic analyzer is unique . . . The catalytic combustion cell produces a larger signal output than conventional detection methods, making possible an extremely sensitive instrument with simple circuitry and controls . . . In the early 1900s, the technique



now known as chromatography was first developed and used to separate the components of liquid solutions. Solutions containing several pigments, or solutions of petroleum hydrocarbons, were filtered through a finely powdered adsorbent contained in a glass column . . . In the 1940s, the technique was extended to accomplish the separation of molecular components in complex gas mixtures . . . A measured sample of the gas to be analyzed was introduced into the chromatographic column . . . packed with finely powdered adsorbent (or liquid coating on an inert material). An eluting, or carrier, gas is continuously passing through the column . . . (*From new* 12-*page Interim Technical Bulletin* 15-211, *Davis Instruments, Div. of Davis Emergency Equipment Co., Inc.,* 47 *Halleck St., Newark* 4, *N. J.*)

For this literature circle **163** on inquiry card.

Time Function Integrator

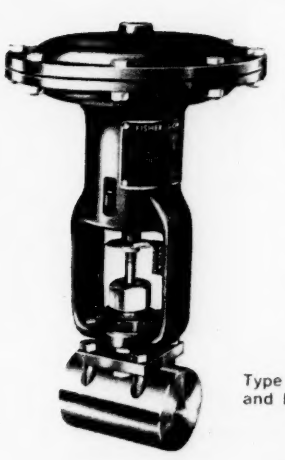
The SIE CR-2 Time Function Integrator furnishes instantaneous, integrated digital readout of areas under voltage varying functions. An example is the measurement of the signal peaks produced by chromatographs . . . A small varying DC input is provided from the usual thermal conductivity cell in a chromatograph or from some other similar source. A precision attenuator provides a constant 100 ohm input impedance. The signal is then amplified by two linear magnetic amplifiers and fed to a linear magnetic integrator which produces a pulse rate proportional to the voltage input . . . (*From new* 2-*page Leaflet CR-2, Southwestern Industrial Electronics Co.,* 2831 *S. Post Oak Rd., P.O. Box* 13058, *Houston* 19, *Texas*)

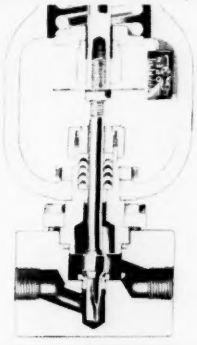
For this literature circle **164** on inquiry card.

"Hand size" control valve for all corrosive applications

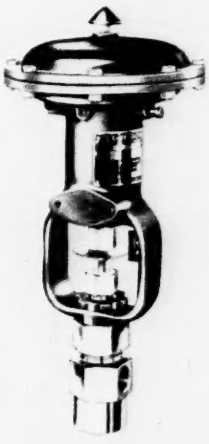
- **Inexpensive and highly dependable.**
- **Available in globe or angle body single port construction.**

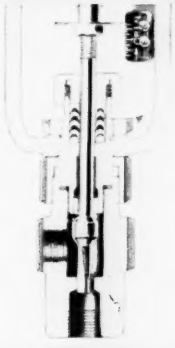
Fisher now offers the low cost, dependable "BA" angle body and the "B" globe body valves for use on heavy duty applications involving corrosive liquids. Bodies are machined from 316 stainless steel bar stock, or other alloys such as Monel or Hastelloy. Either body can be supplied with Type 510 spring open or Type 511 spring closed diaphragm actuator. Normal diaphragm range 3 to 15 psi.





Type 510-B valve with globe body and bolted bonnet construction.





Type 511-BA valve with angle body and a union nut bonnet.

CONSTRUCTION AND SPECIFICATIONS	
Valve Body Sizes	1/2", 3/4" and 1" only with screwed end connections.
Inner Valve	Micro-flute or Micro-form.
Orifice Sizes	1/4", 3/8", 1/2" and 3/4" for the 1" size body. 1/4", 3/8" and 1/2" for the 3/4" size body. 1/4" and 3/8" for the 1/2" size body.
Max. Body Pressure	1500 psi at 450° F.
Overall Dimension	Approximately 15" with the Type 510 or Type 511 topwork on either a "B" or "BA" body.

For complete information write for Bulletin 57 B.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

FISHER

SINCE 1880

For more information circle **29** on inquiry card.

TELETAX* TELEMETERING

by Foxboro...

engineered for the most advanced transmission techniques

Telemetering matched in performance with famous Foxboro instruments — that's the Foxboro Teletax Telemetering System.

Through use of impulse-duration signals, Teletax electrically transmits measurements of a remotely-located variable to the central control station. Here, the Teletax receiver records the duration of impulse, which is directly proportional to the measured variable.

The Foxboro Teletax System is noted for its simplicity, its versatility, and its high sustained accuracy. For a transmission medium, it can use either AC or DC, an audio frequency carried on a transmission line, or radio or microwave impulses. Sustained accuracy is 0.5% of full scale.

TELETAX RECEIVERS

Teletax receivers include: Single or Dual Receivers; Multi-Record Receivers for recording up to 6 separate measurements on one chart; and Teletax Receiver-Controllers for automatic operation. And the Teletax signal can be simply converted to digital information.

TRANSMISSION LINK

With Foxboro's Teletax Telemetering System, you can use the most advanced transmitting techniques: two wire lines, power lines, radio or microwave. As many as 25 different signals can be handled in each direction, simultaneously.

TELETAX TRANSMITTER

The Teletax Transmitter houses either one or two standard Foxboro measuring elements — plus the Teletax transmitting mechanism. It will transmit to a control center hundreds of miles away just as easily as to one nearby. It also indicates or records locally if desired.

The Teletax Transmitter needs no periodic maintenance whatever, while the receiver requires only occasional oiling. And the receiver has a minimum of mechanical components to wear — no clutch to slip or jam.

Foxboro Teletax Systems are now in wide use on natural gas systems, water works, oil fields, power plants, steel mills, etc. Write for Bulletin 17-11C — it gives all the details. **The Foxboro Company, 469 Neponset Avenue, Foxboro, Mass.**

FOXBORO
REG. U.S. PAT. OFF.

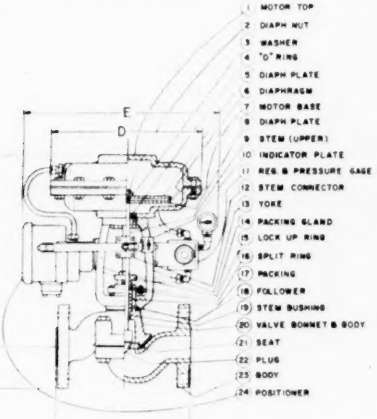
TELETAX TELEMETERING

*Reg. U. S. Pat. Off.

For more information circle **30** on inquiry card.

Split-Body Springless Valves

Split body eliminates flange on screwed bonnet type of construction . . . The conventional threaded seat ring found almost impossible to remove in corrosive service has been eliminated. In its place Uniflow type 1000 split body valves have reversible automatic aligning seats clamped between bolted body valves

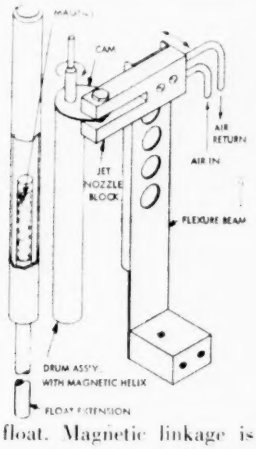


. . . The new Foxboro Type "C" positioner has high sensitivity with full operating air supply pressure applied to diaphragm motor in response to slightest change in controller upward pressure . . . (or) Built-In Positioners, (pneumatic and electric pneumatic) . . . are an integral part of the valve topworks. They use a diaphragm type pilot which is inherently stable . . . (*From new 8-page Bulletin 117, Uniflow Valve Corp., Cranford, N. J.*)

For this literature circle **165** on inquiry card.

Flow-Rate Transmitter

The Brooks MPT-50 transmitter provides a positive means for converting the motion of a rotameter metering float into an output air pressure . . . Derives rotary motion of pointer from vertical, in-line motion



of rotameter float. Magnetic linkage is positive and unbreakable . . . Air output is linear with flow rate over range of 10% to 100% corresponding to 4.2 to 15 psig . . . Linearity is achieved regardless of linearity of float position vs. flow rate . . . (*From new 2-page Design Spec. Sheet 88-170-1, Brooks Rotameter Co., Lansdale, Penna.*)

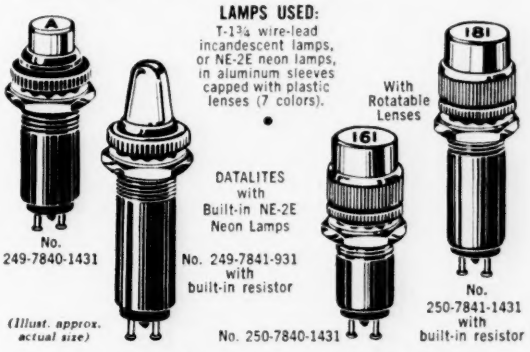
For this literature circle **166** on inquiry card.

In this brochure—complete facts on DIALCO's

DATALITES®

For the Computer-Automation Industries

DATALITES by DIALCO are ultra-miniature Indicator Lights specially designed to meet the critical requirements of the computer-automation fields. Made in 2 basic styles: *Lamp Holders with* DIALCO'S own *replaceable Lamp Cartridges* (see above); or integrated DATALITES *with Built-in Neon Lamps* which are *not replaceable* (see below). Ultra-compact, single units mount in 3/8" clearance hole; the twin-lamp assembly mounts in 3/4" clearance hole.


LAMPS USED:
T-1¾ wire-lead incandescent lamps, or NE-2E neon lamps, in aluminum sleeves capped with plastic lenses (7 colors).
With Rotatable Lenses
181
161
DATALITES with Built-in NE-2E Neon Lamps
No. 249-7840-1431
No. 249-7841-931 with built-in resistor
No. 250-7840-1431
No. 250-7841-1431 with built-in resistor
(Illust. approx. actual size)

DATALITES have fully insulated terminals and conform to all applicable military specifications. Integrated units are available *with or without built-in resistors.* The cylindrical lenses can be hot-stamped with digits, letters, etc. Complete details in *Brochure L-160.* Send for it now.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

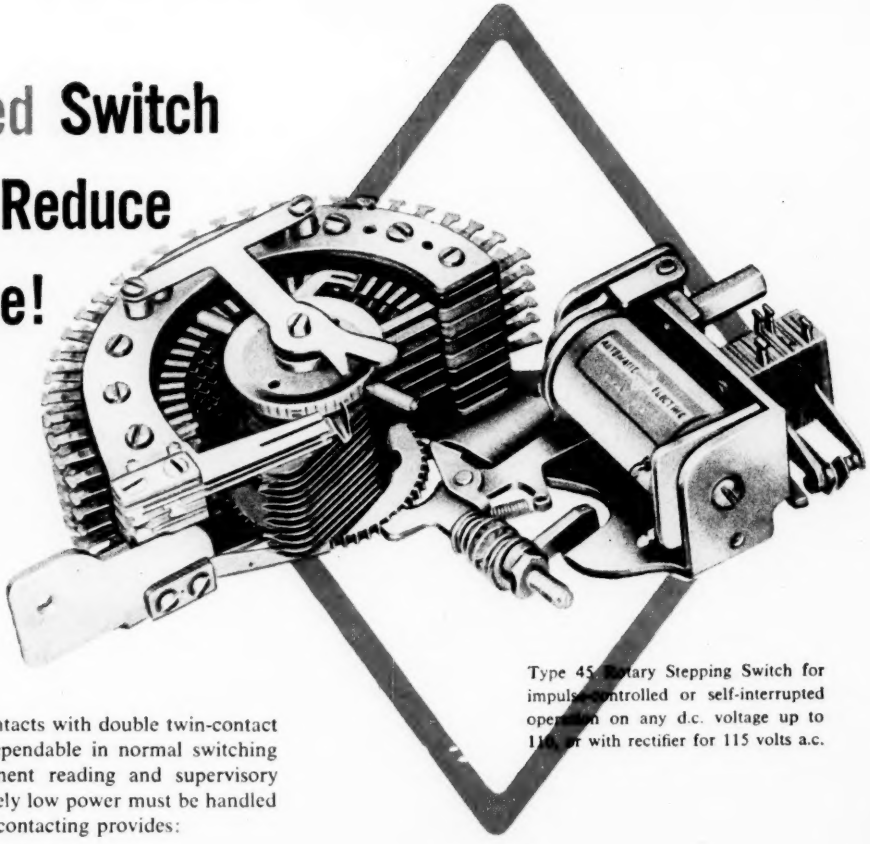
Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

42 STEWART AVE., BROOKLYN 37, N. Y. • HYacinth 7-7600

For more information circle **31** on inquiry card.

Gold-Plated Switch Contacts Reduce Resistance!



Type 45 Rotary Stepping Switch for impulse-controlled or self-interrupted operation on any d.c. voltage up to 110, or with rectifier for 115 volts a.c.

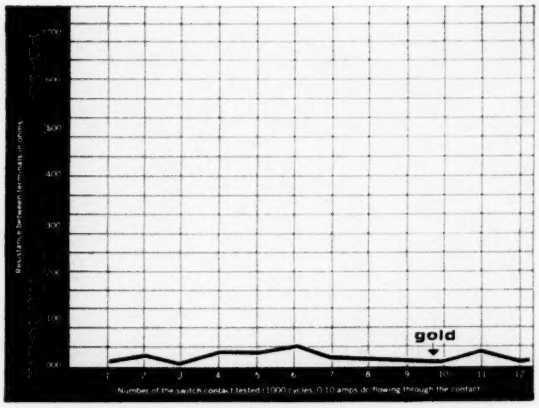
Standard base-metal contacts with double twin-contact design are absolutely dependable in normal switching circuits. But in instrument reading and supervisory functions, where extremely low power must be handled reliably, precious-metal contacting provides:

- *accuracy at lowest potentials*
- *low and constant contact resistance for the life of the switch*
- *freedom from spurious potentials which can be set up by base-metal contacts*

That is why instrument engineers specify gold-plated contacts for thermocouple monitoring and other low-power-level circuits – strain gauges – computers – and infrequently operated devices.

Precious-metal contacting costs more, of course. But with Automatic Electric's custom designing, it is not as expensive as you might think; on either Type 44 or Type 45 Switches, you can specify precious-metal contacts for instrument circuits only, with standard contacts handling the less critical circuits.

For full information on the use of stepping switches–*with or without* precious-metal contacts–ask for Circulars 1641 and 1698. Write: Automatic Electric Sales Corporation, Northlake, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*



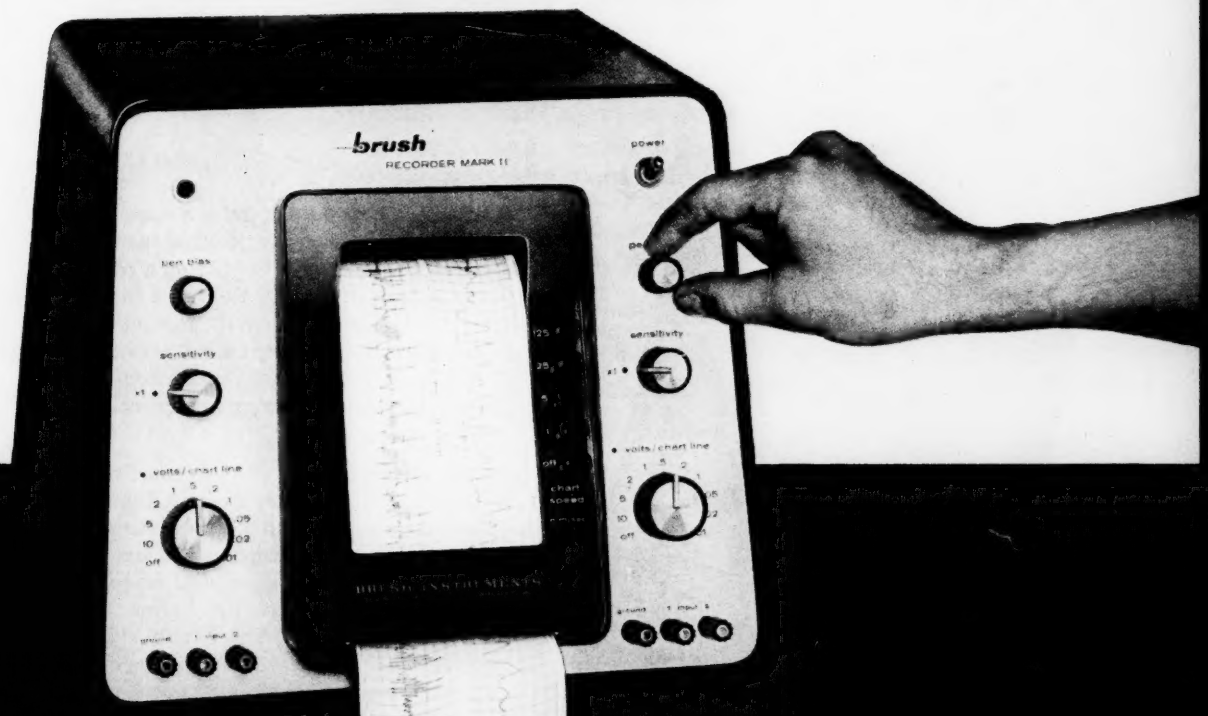
Graph indicates resistances between terminals with gold-plated contacts. Measurements made under heavy vibration.

AUTOMATIC ELECTRIC

Northlake, Illinois • Subsidiary of GENERAL TELEPHONE

For more information circle **32** on inquiry card.

The New Brush Mark opens up whole new world of direct writing applications



Sensitivity
10mv/line (mm). Full scale deflection from chart center ± 200 mv.

Measurement Range
.010v. to 400v.

Input Impedance
5 megohm single-ended, 10 megohm balanced.

Frequency Response
D.C. to 100 cps.

Recording Channels
Four, 2 event channels and 2 analog.

Chart Speeds
1, 5, 25, 125 mm/sec.

Power Requirements
105-125v., 60 cps, 135 watts at 115v.

The portability and remarkable simplicity of the Brush Mark II make it practical to use *anywhere.*

Wherever you work—in research, design and development, production, field testing—you get an immediate *ultralinear* record of performance . . for quick analysis and corrective action on the spot . . . for study at a later date . . . for reproduction by conventional low-cost copy methods.

As foolproof as you'd hoped for, this recorder has built-in amplifiers, permanent calibration, instant paper loading and a "white glove" writing system. Use it as a recording voltmeter . . . as a supplement to your "scopes".

CALL-WRITE-WIRE for immediate shipment from stock — $1350 F.O.B. Cleveland.

brush INSTRUMENTS
DIVISION OF
3405 PERKINS AVENUE **CLEVITE** CORPORATION CLEVELAND 14, OHIO

For more information circle **33** on inquiry card.

NEW American®
GASCLOK Power Drive
constant high power • uniquely accurate

Actual Size

American's new ***GASCLOK*** is a completely self-contained air or gas powered instrument drive and timing unit. Supplying a constant power output of over 20 times the torque delivered by conventional spring-wound clock mechanisms, it is ideally suited as either original or replacement equipment where continuous power and accurate timing are essential.

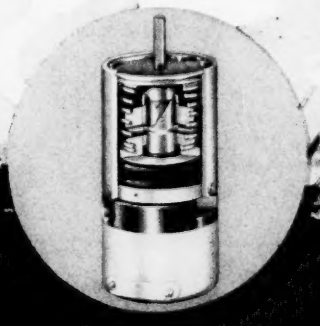
Perfect for all circular or strip chart records from one-hour to 30-day periods. Constant power and timing accuracy are assured since there is no "mainspring" to weaken or run down. Rugged durability and dependability are built into the ***GASCLOK*** Power Drive for years of service with minimum maintenance. It can provide new metering accuracies and economies for you.

for instrument driving and timing
self-starting • air or gas operated

The versatile ***GASCLOK*** Power Drive is designed and field-tested for long trouble-free operation in remote location installations with all makes and types of recording instruments.

The high-torque, continuous drive provides power for: *Integrating Orifice Meters—Gas Lift Meters—Pressure Recorders Strip Chart Recorders—Telecounter Units—Field Program Timers* and many other instrument applications for accurate, automatic operation.

- **Self-starting mechanism completely self-contained—requires no winding or "priming" of power unit.**
- **Gas or air consumption only 5 cfh—normal operating pressure 5 psi—rotation 2 rpm.**
- **Timing escapement spring rewound every 5 seconds—eliminates fluctuating torque.**
- **Accuracy of timing unaffected by wide fluctuations in supply pressure.**
- **Timing mechanism internally sealed to prevent corrosion and clogging—all power unit parts exposed to gas are aluminum or stainless steel.**
- **Inherently explosion-proof.**
- **Large area internal ports to prevent plugging. All internal ports easily cleaned.**
- **Installation in any position—variety of mounting brackets available.**

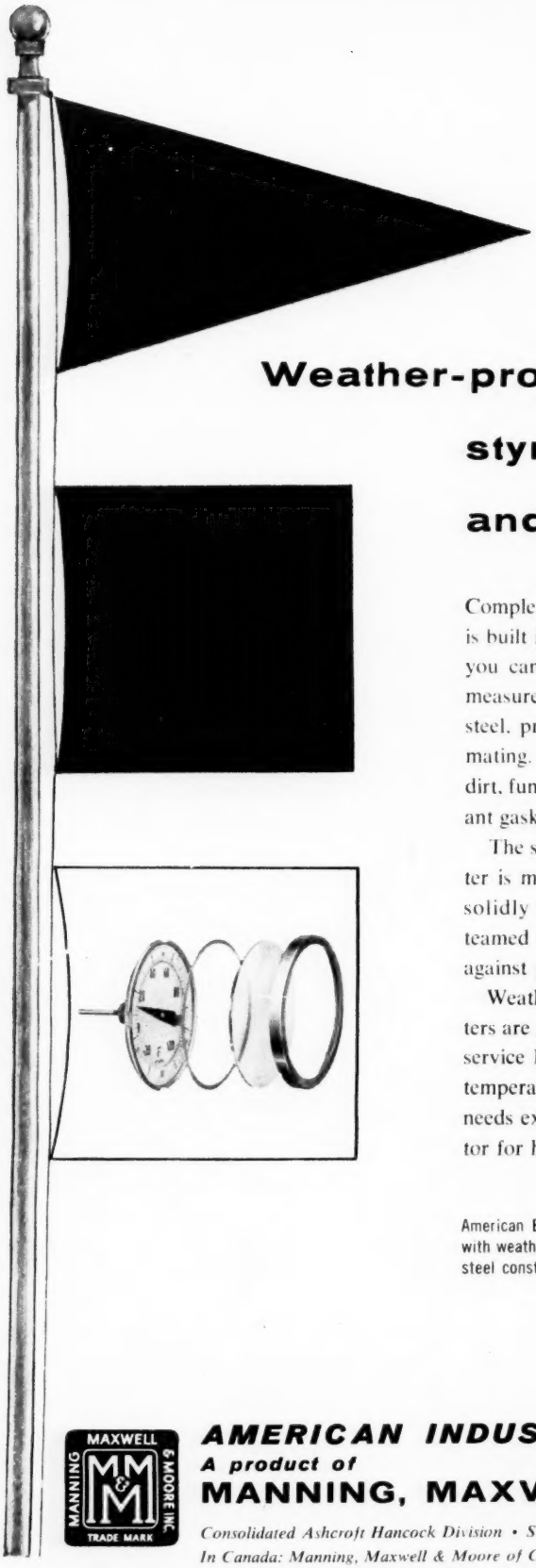


AMERICAN METER COMPANY

INCORPORATED ESTAB. SINCE 1836

AMERICAN METER CO EST. 1836 MEASUREMENT ENGINEERS

For more information circle **34** on inquiry card.



Weather-proof construction stymies erosion and corrosion

Complete protection against erosion and corrosion is built into American Bi-Metal Thermometers, so you can always be sure of accurate temperature measurement. Both case and bezel are stainless steel, precisely fitted and gasketed to insure snug mating. Whatever the weather, rain, sand, dust, dirt, fumes and frost are sealed out by a heat-resistant gasket between case and thick cover glass.

The stem of the American Bi-Metal Thermometer is mirror-smooth stainless steel. All joints are solidly welded. Top resistance to corrosion is teamed with strength, rigidity and tight closure against process pressures.

Weather-proof American Bi-Metal Thermometers are noted for high sustained accuracy and long service life. There are mounting styles, dial sizes, temperature ranges and stem lengths to meet your needs exactly. Ask your industrial supply distributor for help in proper selection.

American Bi-Metal Thermometer with weather-proof stainless steel construction.

MANNING MAXWELL & MOORE INC. TRADE MARK

AMERICAN INDUSTRIAL THERMOMETERS

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **35** on inquiry card.

BOOK Reviews

Strain Gage Instrumentation, edited by M. H. Aronson and R. C. Nelson, 110 pages, 8¼" x 5½", paper, Instruments Publishing Co, 845 Ridge Ave. Pittsburgh, Pa., 1958, $2.00. Twelve chapters by nine authorities in the field cover principles, gage performance, application factors, sensitivity ratings, high-temperature effects, etc. Unique feature is survey of available commercial equipments with pictures of strain-gage instruments and accessories.

Permanent Magnet Handbook, edited by Earl M. Underhill. [c1957.] Crucible Steel Co. of America, Pittsburgh 22, Pa. various paging, loose-leaf binder. 356 pages, $10. 9 in. Deals with design and measurement of magnets, ferromagnetism, magnetization and demagnetization, and the various steels and other materials used for construction of magnets.

Technology Of Instrumentation by Eric B. Pearson [c1957] D. Van Nostrand Co., Inc., Princeton, N. J., 202 p., $4.75, 8¾" x 5¾", cloth. Written for students and new appointees in industry, it uses classical methods for solving differential equations of motion to determine accuracy of instruments and in the study of servomechanisms. Contains also introduction to computers.

Introduction To The Design Of Servomechanisms by John L. Bower and Peter M. Schultheis, [c1958] John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 510 p., clothbound, $13.00, 9¼" x 6". Deals with principal performance requirements, such as harmonic response, time response, error coefficient, and noise response on undergraduate level, with examples and problems. Appendix describes some servomechanism components and their transfer functions.

Handbook of Automation, Computation and Control, Vol. 1, edited by Eugene M. Grabbe, Simon Ramo, and Dean E. Wooldridge [c1958] John Wiley & Sons, Inc. 440 p., $17, 9¼" x 6" clothbound. First of 3 volumes covers "Control Fundamentals." other 2 volumes are in press. Half of the 26 chapters deal with general mathematics including integral equations, complex variables and Boolean algebra. Contains numerical-analysis methods and the

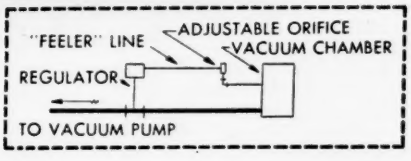
Continued on page 1785

VACUUM REGULATION

...Fulton Sylphon is your No. 1 source!

Simple! Compact! Powerful! All-metal Fulton Sylphon No. 994 Vacuum Regulator provides superior performance at low cost in low pressure and vacuum service. Dependable, large-size Sylphon® Metal Bellows and tension-compression loading spring assure accurate control and long life. Widely used in food, chemical and pharmaceutical processing. Models available to provide reduced pressures from −14 to +20 psi. National field service . . . complete engineering assistance. Write for Bulletin TP-103-JG.

Typical vacuum regulator application—reverse-acting valve closes when the vacuum increases.



Air Controls

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION
Knoxville 1, Tennessee

For more information circle 36 on inquiry card.

THE FIRST NEW CONCEPT IN DIGITAL DISPLAY SYSTEMS

Cubic

TRANSISTORIZED SYSTEMS

with built-in

rely/ance*

* Cubic's engineering philosophy regards reliability and ease of maintenance as inseparable features of a truly functional system.

ONLY CUBIC DIGITAL DISPLAY SYSTEMS GIVE YOU:

LOW COST OF OPERATION

Proven reliability and practical maintenance features reduce costly down-time to a minimum.

VERSATILITY

All systems units standard size: each unit plugs into its own chassis; modifications for special equipment readily available; interchangeable units ideal for rack mounting.

RELIABILITY

Accuracy to .01%; resistor stability assured; complete transistorization eliminates warm-up time.

EASE OF MAINTENANCE

Stepping switches mounted on horizontal bars — swing up and out for easy access. Slide-out features allow quick replacement if system requirements change.

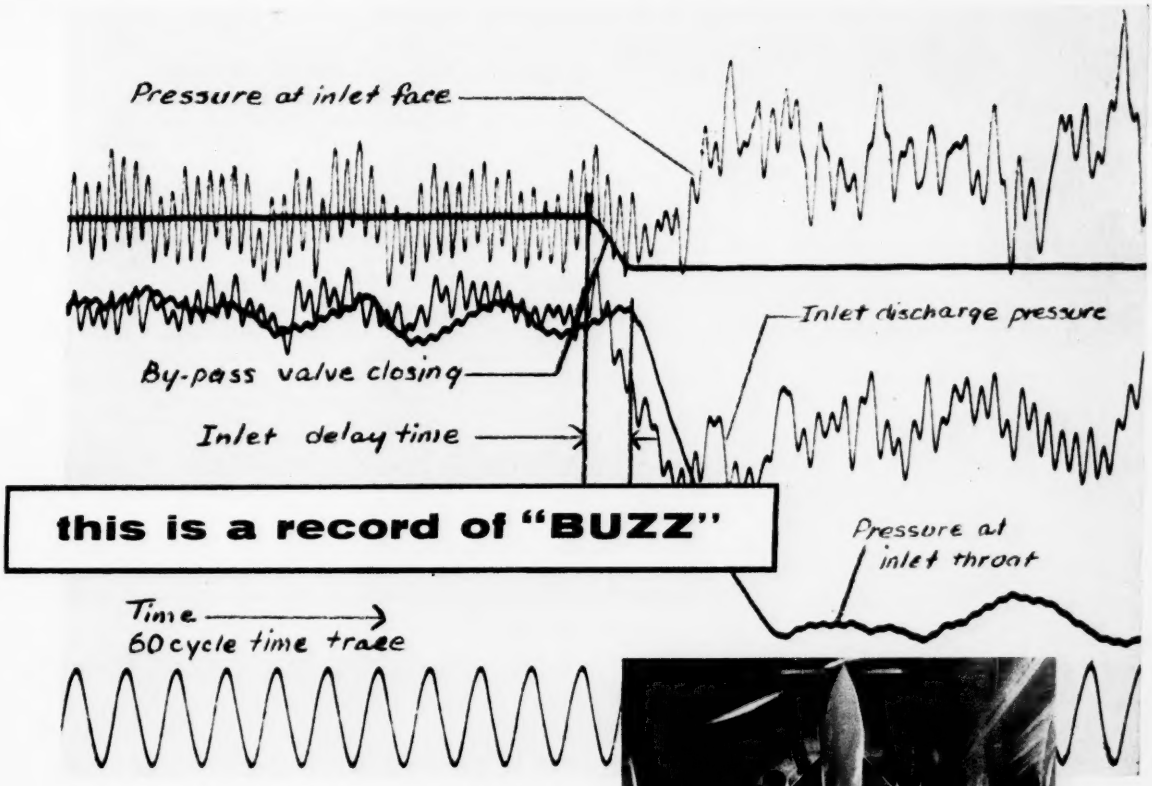
Cubic CORPORATION

Compare Cubic Digital Systems . . compare them for price, reliability and versatility. A fast prove-it-yourself demonstration will show you why Cubic Digital Systems will be your best instrument aid.

For complete information and/or demonstration call **BR 7-6780**

5575 KEARNY VILLA RD.
SAN DIEGO 11, CALIFORNIA

For more information circle **37** on inquiry card.

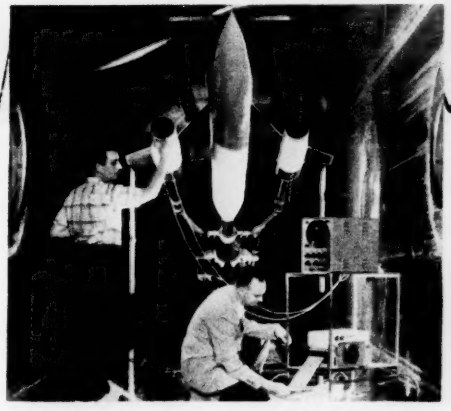


The Visicorder charts pressure fluctuations in a supersonic inlet

A Model 906 Honeywell Visicorder wrote this record of pressure fluctuations . . . "buzz" . . . for the National Advisory Committee for Aeronautics at the Lewis Flight Propulsion Laboratory in Cleveland. Buzz is the term used to describe unsteady variation in pressure and airflow characteristics of a supersonic aircraft or missile inlet.

The purpose of these Visicorder studies is to define the buzz-free operating limits of the inlet, and to provide the designer with structural load information in case the inlet is inadvertently caused to operate on buzz during flight. This is particularly important because inlet buzz can result in fluctuating structural loads of the order of 1000 psf. Depending on the inlet design, this could cause structural failure of the inlet and loss of the airplane.

High response pressure transducers are used to measure these fluctuating pressures and the resulting electrical signal is fed into the Visicorder. Records such as this are also necessary in the determination of the inlet dynamics such as delay time. This information is then used to design inlet control systems.



NACA engineer examines VISICORDER records.

The HONEYWELL VISICORDER is the first high-frequency, high-sensitivity direct recording oscillograph. In laboratories and in the field everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Honeywell

Heiland Division

Reference Data: Write for Visicorder Bulletin

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado

For more information circle **38** on inquiry card.

Easy does it

when you postform plastic

with the help of

a Fenwal 541 Temperature Indicating Controller

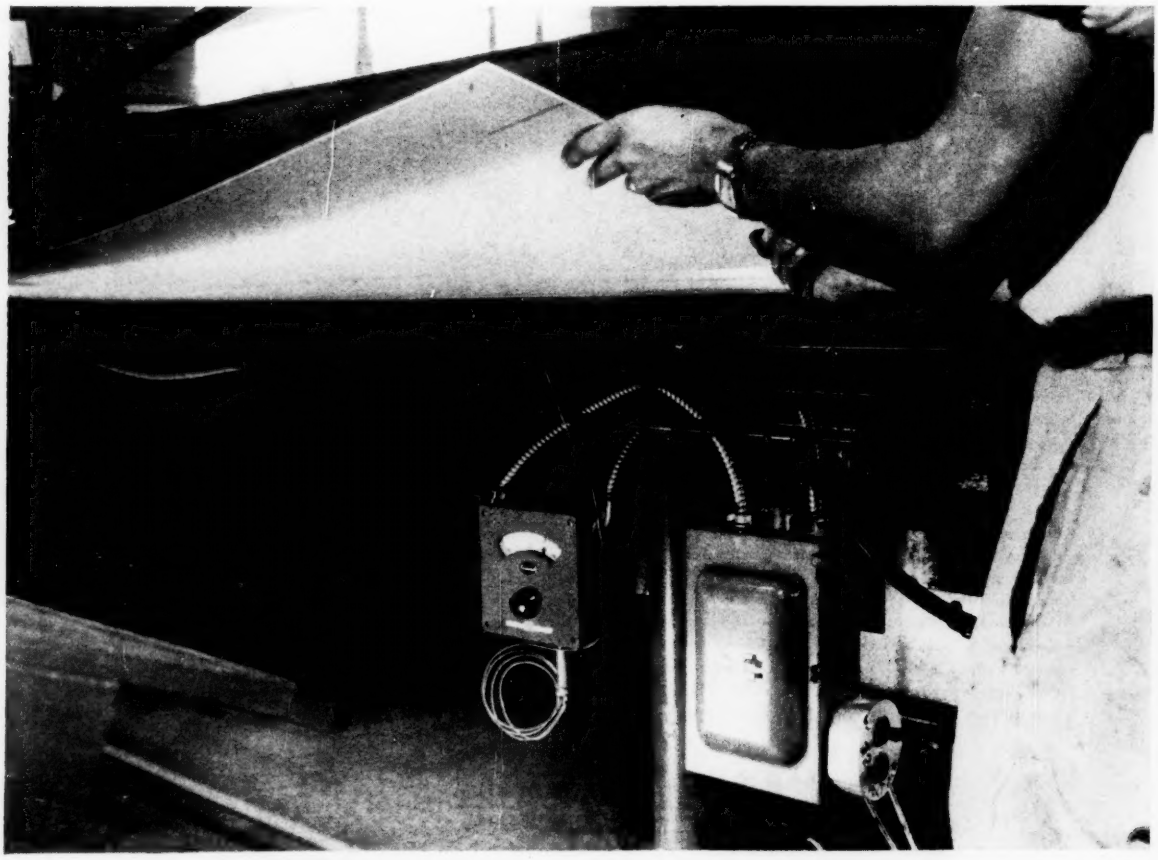
Whether you postform laminated plastic (the machine here is heating a seamless phenolic plastic counter top), or rely on temperature indicating controllers for any of a thousand other reasons, *Fenwal's 541 is the easiest to operate!*

The 541 has a host of long life features — corrosion proof 316 stainless steel, swivel mounted capillaries and bulbs . . . splash and dust proof housing. Self-compensating wear means continued accuracy with minimum maintenance. All components are accessible, easy to adjust. *It's simple and reliable!*

With ranges from −150° to +700°F., the 541 can accurately control one, two, or four circuits. Choose from several bulb and capillary styles, four basic models, variety of housing colors — hundreds of combinations to solve *your* temperature control problem. *It's versatile!*

Find out more about this Fenwal temperature indicating controller that is virtually custom-designed for you. Write to Fenwal Incorporated, 3611 Pleasant Street, Ashland, Massachusetts, and ask for a catalog or a sales engineer.

Precise temperature controls on this press make postforming thermoset plastics easy, quick, nearly automatic. This is our single circuit model (there are 575 others) with one SPDT switch and one control pointer. Housings on all Fenwal 541's meet NEMA and JIC specifications.



Fenwal

CONTROLS TEMPERATURE . . . PRECISELY

For more information circle **39** on inquiry card.

BOOK REVIEWS—Contd.

latest digital computation techniques. Major objective is to provide data for design of digital devices and control systems.

Static Control Application Manual—GET-2909 third edition, [c1958] General Electric Co., General Purpose Control Department, Schenectady 5, N. Y., 152-p. $5, paperbound. Discusses what static control is and tells why, when and where it should be used for general-purpose industrial applications.

Digital Differential Analyzers. Ed. 4. by George F. Forbes. 1957. Pacoima, Calif. various paging, unbound. $5. 11 in. A manual for digital and Bush type differential analyzers. Presupposes some knowledge of calculus and differential equations.

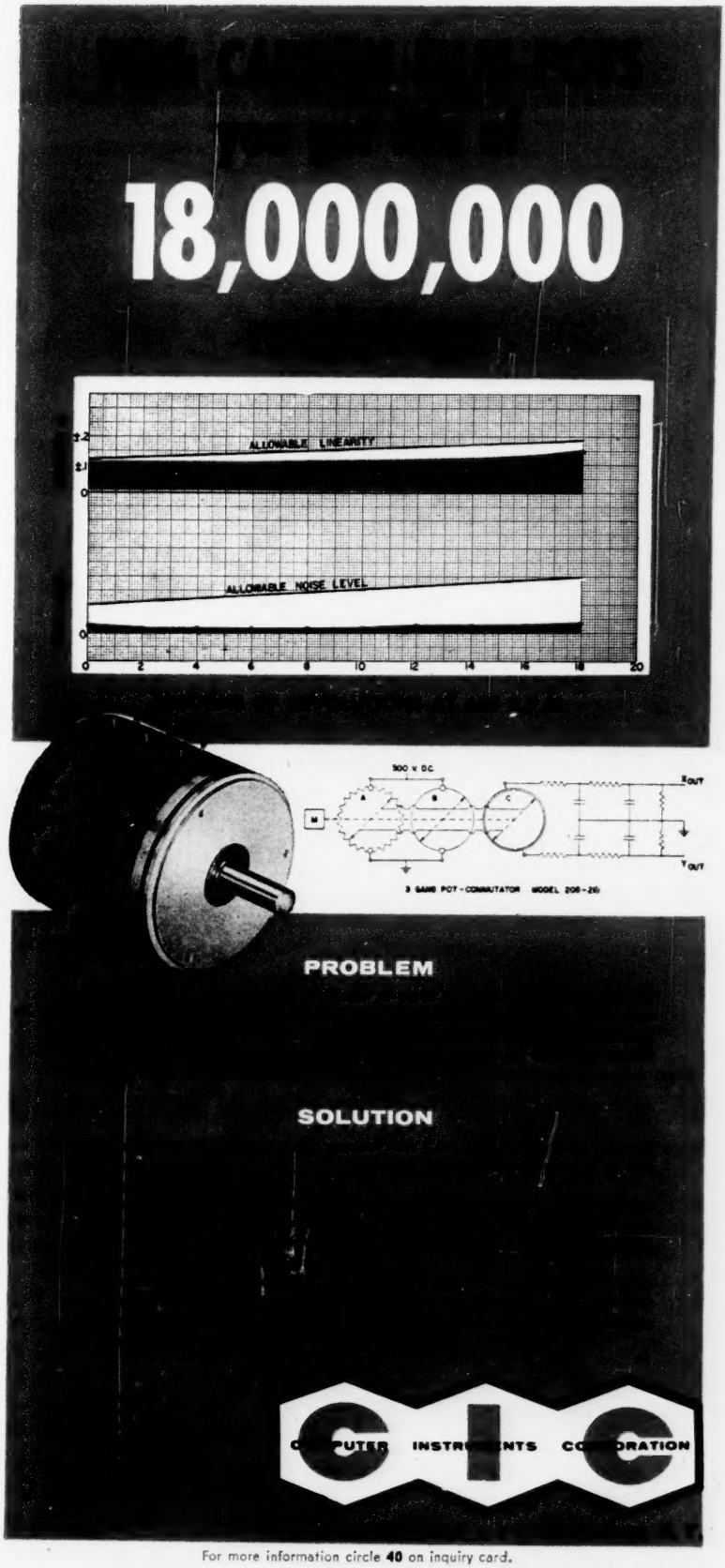
Plant and Process Dynamic Characteristics. 1957. Butterworths Scientific Publications, London, W.C.2. 246p. 50s. 8¾ in. Proceedings of a Conference (April 4-6, 1956) of the Society of Instrument Technology in Cambridge, England. Eleven highly technical papers, with discussion.

Basics of Digital Computers, by John S. Murphy. Vol. 1 (196-1) is 116 pages; Vol. 2 (196-2) is 133 pages; Vol. 3 (196-3) is 136 pages. 6″ x 9″. paper. John F. Rider Publisher. 1958. $2.50 per volume; $6.95 per set. Uses "pictorial" approach to on-off and code fundamentals (Vol. 1), basic logic elements (Vol. 2), and pulse reading and writing (Vol. 3). An elementary introduction in picture language.

Electrical Discharges in Gases, by F. M. Penning. [1958.] Macmillan Co., New York 11, N. Y. 75p. $3. 9 in. Translated from Dutch by A. F. Monypenny. Based on author's lengthy investigations in Philips Research Laboratories, Eindhoven, Holland.

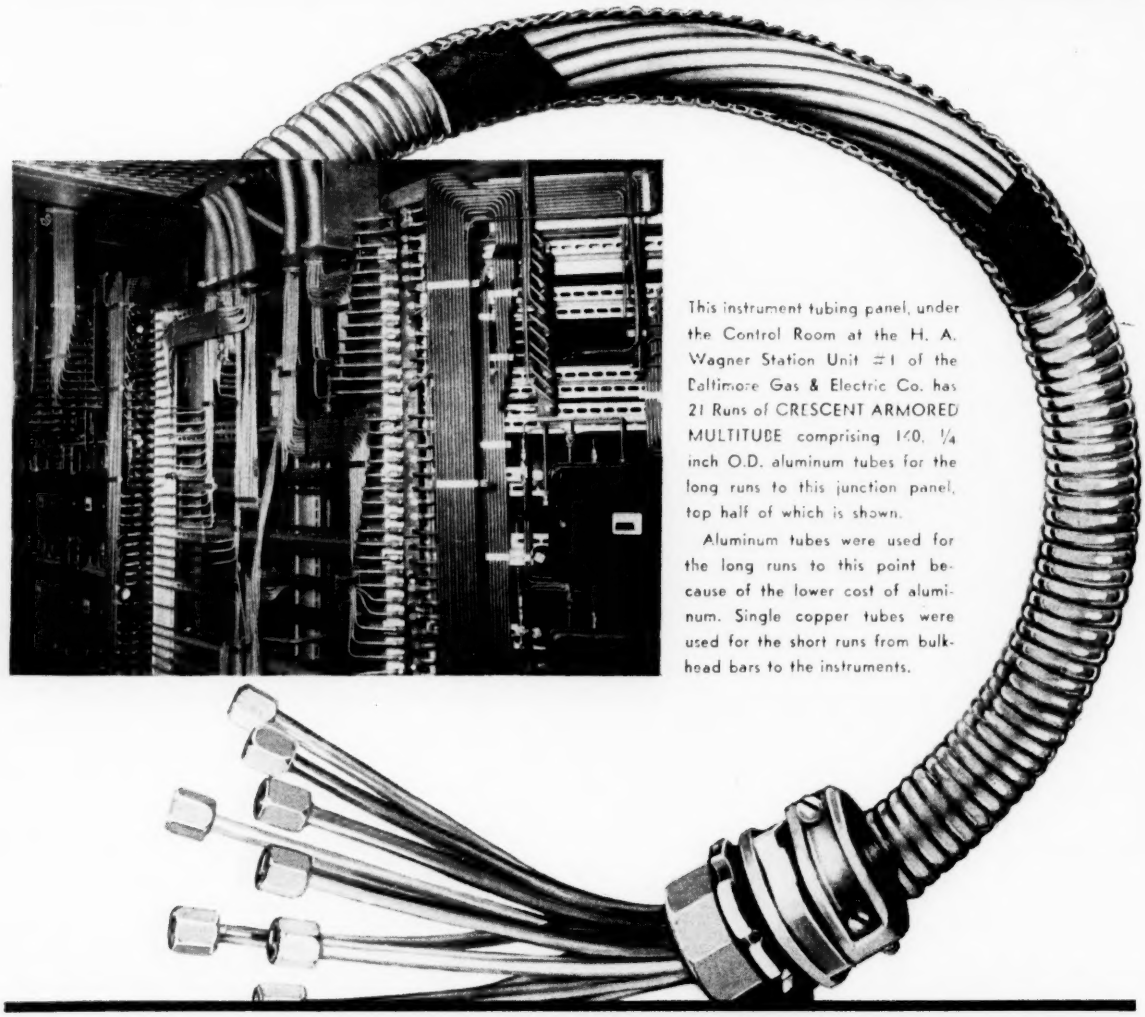
Magnetic Recording Techniques, by W. Earl Stewart. 268 pages, 6″ x 9″, cloth, McGraw-Hill Book Co., 1958, $8.50. An engineering text covering the basic design factors and operating principles of magnetic recording and reproduction.

The Computing Laboratory in the University, edited by Preston C. Hammer. 1957. Univ. of Wisconsin Press, Madison 6, Wis. 236p. $6.50. 9½ in. A collection of 31 papers at a conference in 1955.



For more information circle 40 on inquiry card.

CRESCENT ARMORED MULTITUBE*



This instrument tubing panel, under the Control Room at the H. A. Wagner Station Unit #1 of the Baltimore Gas & Electric Co. has 21 Runs of CRESCENT ARMORED MULTITUBE comprising 140, ¼ inch O.D. aluminum tubes for the long runs to this junction panel, top half of which is shown.

Aluminum tubes were used for the long runs to this point because of the lower cost of aluminum. Single copper tubes were used for the short runs from bulkhead bars to the instruments.

for dependable performance of instrumentation and control tubing

CRESCENT ARMORED MULTITUBE® is a group of tubes spirally cabled together. One tube in each layer is a bright blue color, which makes identification of any tube at both ends an easy matter.

Users report savings in installed cost of from two to five times the cost of CRESCENT ARMORED MULTITUBE as compared with the old method of using single tubes. Using the MULTITUBE system will result in fewer connections and fittings, lower cost for supports or racks, ease of mounting and less space.

The spiral cabling of the tubes prevents distortion when the entire assembly is bent on a short radius. The tubing assembly is protected by a flexible, interlocked galvanized steel armor, or by a tough corrosion-resistant thermoplastic sheath or both.

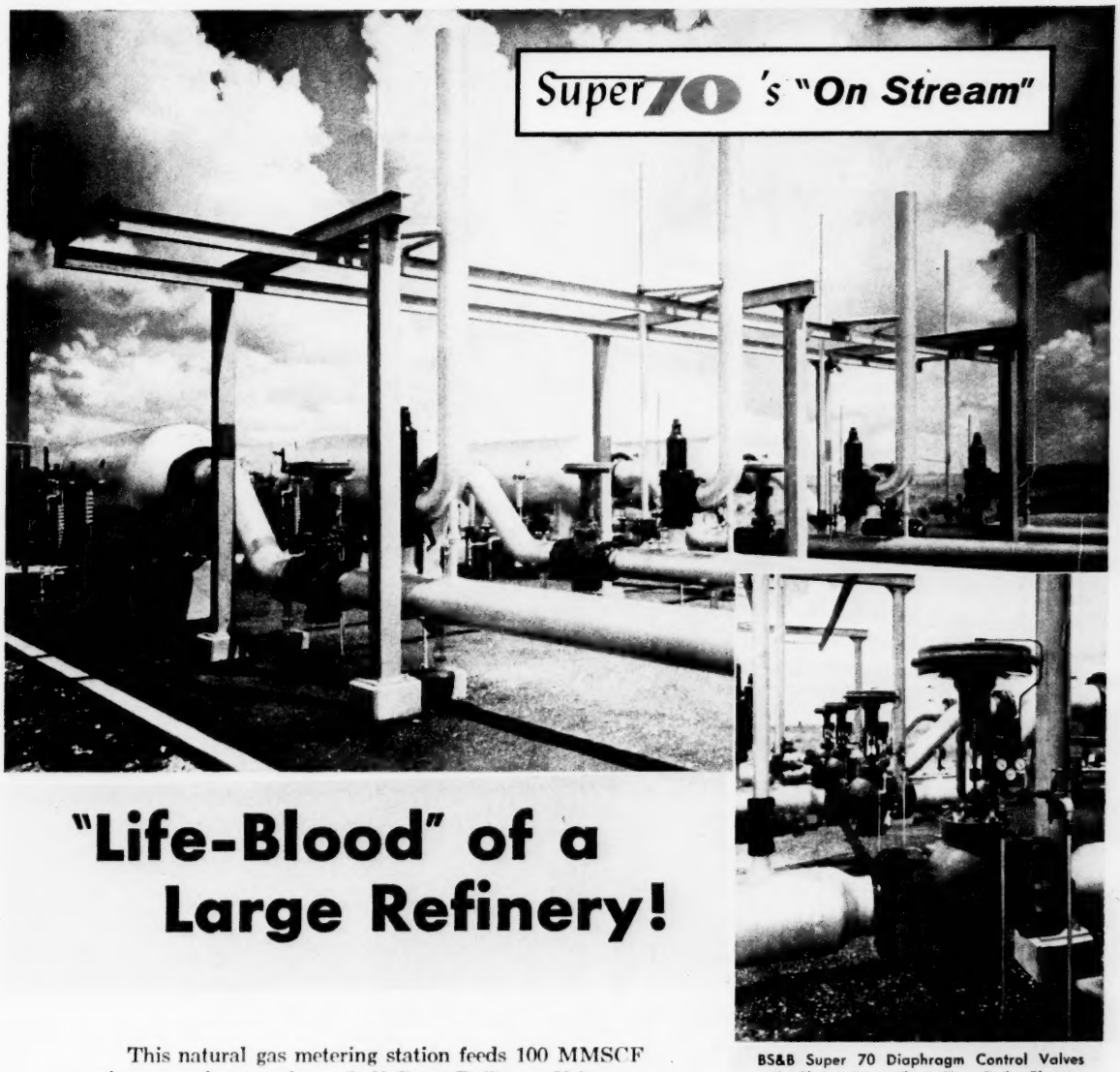
Furnished in from 2 to 37 Tubes of copper, aluminum, steel, polyethylene up to 1000 feet. Also special construction for underground runs. This product is licensed under U.S. Patent 2,578,280.

Send for Bulletin 356-A giving complete information and engineering data

CRESCENT INSULATED WIRE & CABLE CO.

TRENTON, NEW JERSEY

For more information circle **41** on inquiry card.



"Life-Blood" of a Large Refinery!

This natural gas metering station feeds 100 MMSCF of gas per day to a large Gulf Coast Refinery. If it were necessary to shut down the station for repairs, operation of the refinery would be seriously impaired.

That's why engineers who designed the station wanted to be absolutely sure the control valves would function properly day in and day out under all operating conditions.

Because of their superior performance characteristics and rugged dependability . . . and because of BS&B's reputation for quality products and dependable service in the oil industry . . . BS&B Super 70 Control Valves were selected. Now "on stream", they are performing well in every respect.

BS&B Super 70 Valves are available in a complete range of sizes . . . with either clamp ring—float ring, or flanged—gasketed body closures. Specify them on your next job!

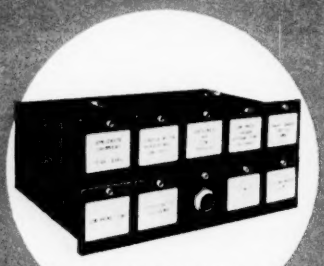
BS&B Super 70 Diaphragm Control Valves with Clamp Ring—Float Ring Body Closure.

BLACK, SIVALLS & BRYSON, INC.

Controls Division,
Dept. 4-VII
7500 East 12th Street
Kansas City 26, Missouri

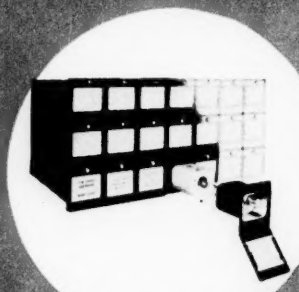
SUPER BS&B 70

For more information circle **42** on inquiry card.



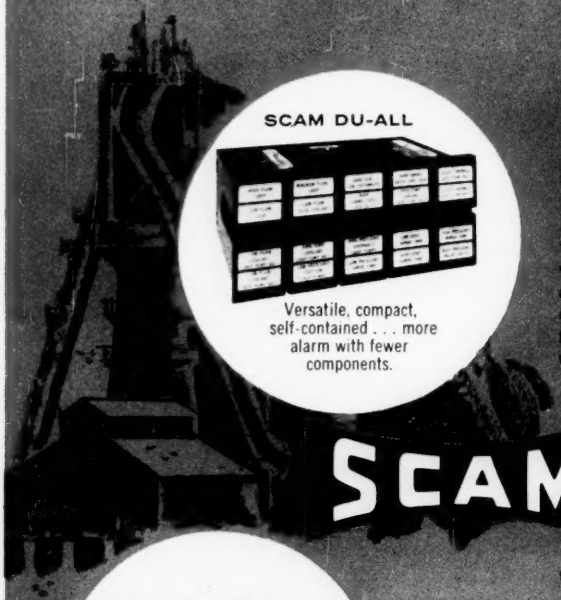
SCAM DE-LINE

Building-block principle plus all desired alarms and sequences give this system extreme flexibility.



SCAM DE-LINE provides maximum flexibility. Widely used in the Power Industry . . . Central Generating Systems.

Controls and alarms for every requirement!



SCAM DU-ALL

Versatile, compact, self-contained . . . more alarm with fewer components.

proved reliability
low initial cost
complete design flexibility

Regardless of the operation or process you wish to control or the alarm network you need to set up, SCAM INDUSTRIAL MONITORING SYSTEMS will meet your requirements with remarkable efficiency and reliability. Modular components and construction for most applications; custom units for special situations.

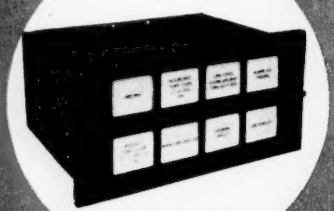
SCAMMIT-STATIC SWITCHING

Monitoring systems for process and automation control . . . no moving parts.

SCAM® INDUSTRIAL MONITORING SYSTEMS

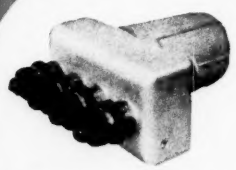
WRITE TODAY . . . for complete information and literature

Complete Monitoring Systems for Industry



SCAM S-LINE

Wide variety of combinations, yet standardized for general purpose needs.



SCAM EXPLOSION-PROOF

Systems designed for safe use in potentially hazardous atmospheres.

SCAM INSTRUMENT CORPORATION

1907 West Irving Park Road • Chicago 13, Illinois
Telephone: GRaceland 7-7850

REPRESENTATIVES IN ALL PRINCIPAL CITIES

For more information circle **43** on inquiry card.

events

November 19-21

Eleventh Annual Conference on Electrical Techniques in Medicine and Biology, Minneapolis, Minn. For information write Dr. O. H. Schmitt, School of Physics, Univ. of Minn., Minneapolis 14, Minn.

November 24-30, 1958

International Measurements Conference, Budapest, Hungary. For further information write Dr. Gyorgy Striker, General Secretary, P. O. B. 3, Budapest 5, Hungary.

November 28-December 4

Electronic Computer Exhibition (including Data-Processing Equipment), Olympia, London. For information write S. S. Elliott, 11/13 Dowgate Hill, London, E. C. 4, England.

December 2-4

Third EIA Conference on Reliable Electrical Connections, Dallas, Texas. For information write W. O. Richards, 224 Cedar St., Syracuse 3, N.Y.

December 3-5

Eighth Annual Eastern Joint Computer Conference and Exhibition, Bellevue-Stratford Hotel, Philadelphia, Penna. For information write John L. Whitlock, 6044 Ninth St., North, Arlington 5, Virginia.

December 3-5

Second National Symposium on Global Communications co-sponsored by the Professional Group on Communications Systems of IRE and AIEE Communications Div., Colonial Inn and Desert Ranch, St. Petersburg, Florida. For information contact Leslie Spencer, c/o 72nd St., N. St. Petersburg, Florida.

December 8-10

American Nuclear Society Annual Meeting, Sheraton-Cadillac Hotel, Detroit, Mich. For more information write Mr. A. S. Griswold, American Nuclear Society, 2000 Second Ave., Detroit 26, Mich.

December 9-11

MAECON (Mid-America Electronics Convention), Municipal Auditorium, Kansas City, Missouri. For more information write MAECON, 5109 Cherry St., Kansas City 10, Mo.

January 12-14

Fifth National Symposium on Reliability and Quality Control, Bellevue-Stratford Hotel, Philadelphia, Penna. For information write William H. Rombach, Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Penna.

...why you save on custom-engineered "one-source" bellows and accessories

* It pays to specify seamless metal bellows *and all assembly components* as one "package"—designed as an integral unit . . . produced to one high standard of quality . . . tested under uniform procedures . . . and delivered already assembled.

Custom-engineered Bridgeport Packaged Bellows save handling, assembling, testing, incoming inspections and paper work in your plant. And you benefit from one source responsibility, no scattered deliveries and lowest possible unit costs.

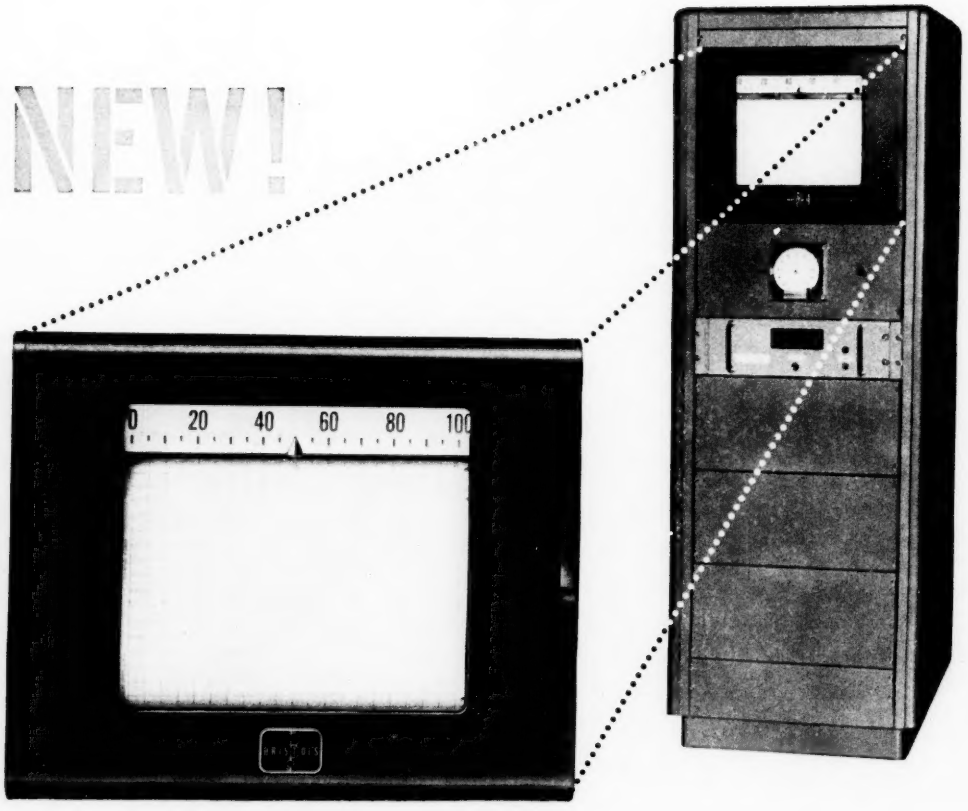
Wide selection of bellows metals permits outstanding uniformity and stability under tough conditions of temperature, pressure, corrosion and vibration. Bellows sizes from subminiature ¼" O.D. up to several inches O.D.

Discuss your Packaged Bellows needs with a Bridgeport engineer . . . or get started right now by writing for Bellows Bulletin F-1011.

Mr. Controls® Robertshaw-Fulton CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION • Milford, Conn.

For more information circle **44** on inquiry card.



BRISTOL'S electronic DYNAMASTER® fits standard relay rack without modification

Here's the first electronic instrument built to fit into a standard 19-inch relay rack with no cutting, no masking, no modification to the instrument or to the rack.

There's a Bristol DYNAMASTER potentiometer and bridge model for every purpose . . .

DYNAMASTERS are available in round- and strip-chart models, and as indicators. The recording models can be supplied as one- or two-pen instruments, or with up to 24 points as a multiple record strip-chart instrument.

DYNAMASTERS can be supplied as electric or pneumatic controllers that are tailored to fit YOUR control needs.

There are standard DYNAMASTER models to suit the special needs of pilot plants, research, and testing. These models include High Speed (0.4 second) recorders, X-Y (Function Plotters) recorders, Extended Range recorders, and Adjustable Span and Zero recorders.

Write for complete data on the new Bristol DYNAMASTER. The Bristol Company, 113 Bristol Rd., Waterbury 20, Conn.

8.37

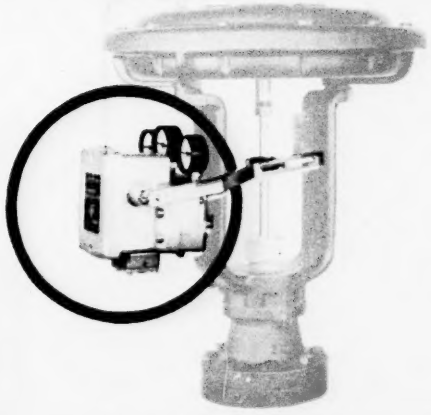
BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

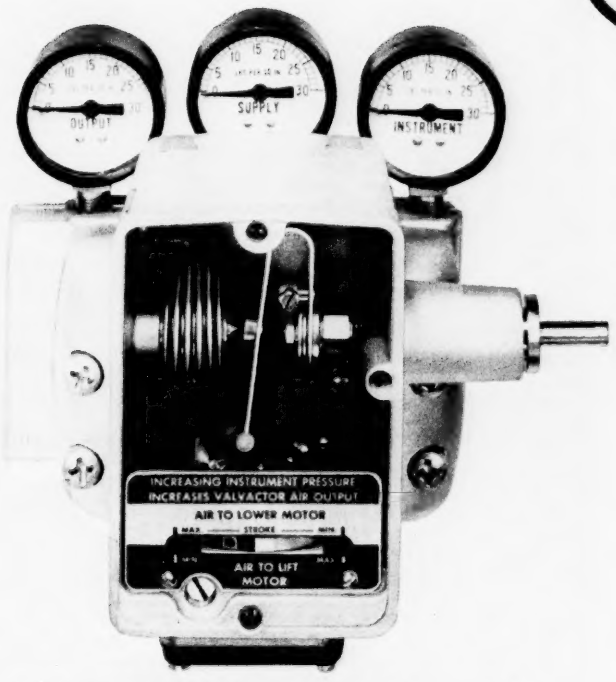
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **13** on inquiry card.

Foxboro Type C
VERNIER VALVACTOR*

MOST UNIVERSALLY ADAPTABLE VALVE POSITIONER ON THE MARKET!





The Type C Valvactor's distinctive motion-balance principle of stem positioning eliminates loading effects of heavy fixed-stroke actuating springs. Note compactness — the simplest mechanical design of any valve positioner.

**Trademark of a precision valve positioner made by The Foxboro Co.*

Unique Flexibility Easily reversible in seconds. Sequencing by two simple adjustments.

Super Response Full air-pressure output to diaphragm motor on signal air-pressure change as small as ½ of 1% of signal span.

Extra Speed New, high capacity relay provides high speed positioning action.

Positive Positioning Direct, motion-balance feed-back assures instantaneous, pin-point positioning.

Now there's a positive-action, super-precision valve positioner that you can easily adapt to *any* diaphragm motor application — without exchange of parts! It's the Foxboro Type C Vernier Valvactor with unique motion-feedback.

The Type C Valvactor has a master setting disc which provides easy change of action as required by the control system, as well as easy reversal of Valvactor action for air-to-open or air-to-close control valves. Adjusting for limited stem travel is equally simple ... sequencing of several valves is a cinch!

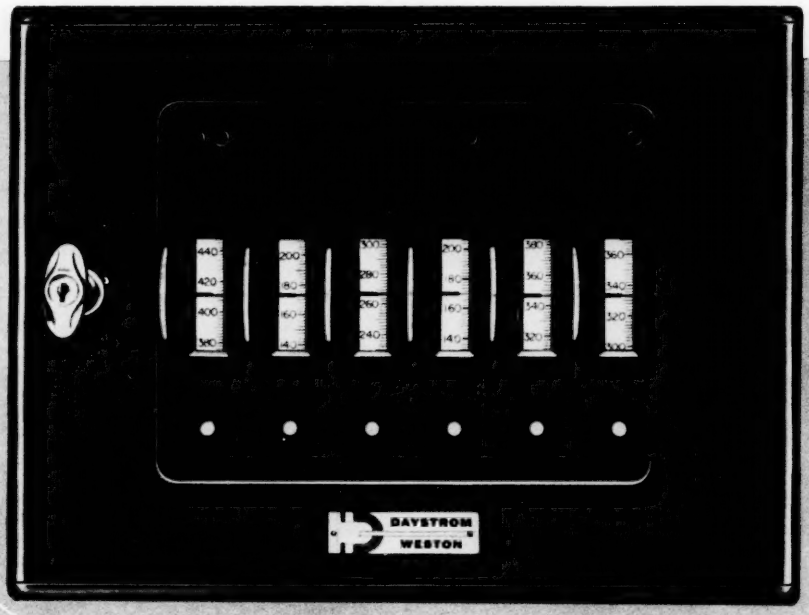
The Valvactor is the ideal solution to such problems as stem friction, plug friction, valve motor and transmission line lag, and extreme process line pressure changes. And it requires practically no maintenance! Available with 3-gauge and by-pass manifold, or plain manifold. Write for full details.

The Foxboro Company, 4611 Norfolk St., Foxboro, Mass., U.S.A.

FOXBORO
REG. U.S. PAT. OFF.

CONTROL VALVES AND POSITIONERS

New! DAYSTROM-WESTON MULTI-POINT NON-INDICATING CONTROLLER



Fully flexible, compact control!

Another first for **UNITIZED*** *design*

Here's an exceptional new tool — the only instrument of its kind on the market — for applications where multiple control is necessary, without the need for chart records. Unitized construction makes possible these *exclusive* features:

- Control units may be added or subtracted in the field . . . for 1-, 2-, 3-, 4- or 6-point operation.
- Unique switching system permits operation with a single electronic amplifier of the null-balance type.
- Individual slide wires and control set points make each control unit independent of the others.
- A minimum of panel space is required; unit will fit any standard relay rack.
- High accuracies are assured, at a cost far below that of a number of separate units.
- Scanning cycle is adjustable to 2, 5 or 10 seconds per point; 2- or 3-position control may be used.
- Many standard ranges are available — and simple, plug-in range clips permit changes in seconds.
- Set points are easily adjusted by large knurled wheels next to the scale windows.
- Revolutionary new D-PAK constant current source eliminates batteries, standard cells, and standardizing mechanisms.
- D-PAK needs no care or service; permits uninterrupted monitoring of processes. No need for frequent standardization.

For complete information, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

* **UNITIZATION:** the grouping of related components — in Daystrom-Weston Potentiometer Instruments — in the simplest, most serviceable, most efficient manner.

DAYSTROM-WESTON

Industrial Instruments

A DAYSTROM UNIT

For more information circle **47** on inquiry card.

Panhandle Pete

THE INSTRUMENT SALESMAN

BLUE Monday, November 10, 1958. Home from the office at last; my gawd, what a day. Nothing right; orders cancelled; called on carpet all day; Old Man got me for excessive expense accounts—me, who has never made more than 50% on the account in my life!

Boss decided to send me to Washington to see army brass about gas analyzers for guided missiles and atomic bombs. "Why don't you go home early? You've made enough mistakes today," says he.

Got home just in time to put up screens, can peas and pluck ducks for our anniversay dinner. Told wife I had to go to Washington . . . she said I was going to dinner . . . went. My gosh but I'm tired. Be glad to hit the sack on the "Capitol Limited."

Went down to the P. & L. E. station to catch B & O No. 6 at 2:05 AM but as I was a little early went across Smithfield Street bridge and stepped into one of the gin mills for some nerve tonic . . . holy smokes! Time flew and I just made it by taxiing back. Pullman porter showed me to roomette; managed to get bed down after removing suitcase from under it. Forgot to pull zipper on curtain and backed out in aisle sans pajamas. Porter pulled down zipper and caught my . . . Oh well, doesn't hurt too much and porter seems sorry. Must remember to sue B & O. Arrived in Washington; raining, no taxis, couldn't find Hertz card, no busses, hitch-hiked to Pentagon.

Pleasant southern-style gal "you-alled" me into army brass waiting room where I sat awhile waiting for some airforce brass to get their feet off the desks, put away the funny papers and rinse out the coffee cups. Leafed through a 1945 *Scientific American*, a 1939 *Electronics Digest* and a 1910 *Hunting and Fishing Guide to the Lower Potomac River Basin*. No wonder we can't get our missiles off the ground; the army is sure behind the times in reading material. Slipped some WESCO! literature in amongst the magazines.

Southern-style gal "you-alled" me into the brass's office. Told Colonel Fogg I represented the newest and most progressive instrument company in the country. While expanding 1005.17% in the last year, we built complete system analyzers, assorted hardware including plows, gas analyzers, Parkometers, O. J. Digital Computers, Snort Air Filters and Unguided Missiles.

Started going into the fine specs of these equipments, but I could tell from the yawns and droopy eyes of the Colonel that I was getting nowhere—so I switched to a new tack.

"Further," I points out nonchalantly, "we have 2074 engineers with water-cooled slide-rules standing by; and our Dr. Otto U. Alles is a graduate of CORG and . . ." here the Colonel nearly fell off his chair in a deep sleep, so I started another line of approach.

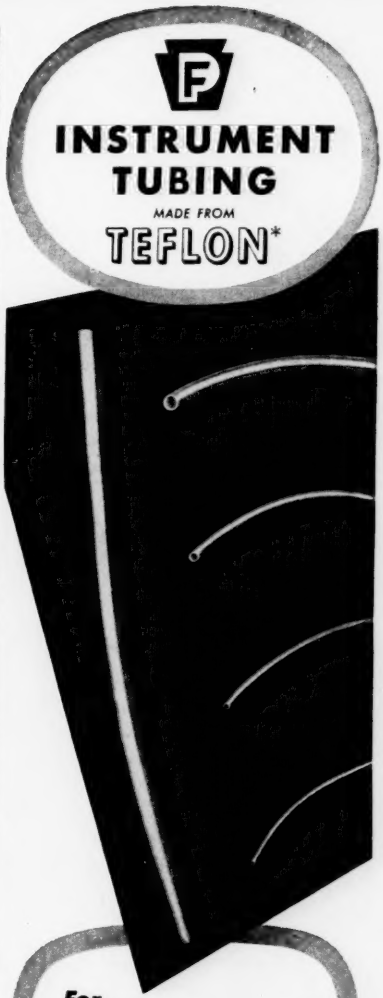
"Foggy, old boy, the guvermint is spending $40.0 billion on missiles, rockets, satellites, soil banks and other related projects. How would *you* like to be the man who saved the guvermint a buck? Think of the reputation you would have; even *Life* magazine would be interested. And you can do that by using our inexpensive line of gas analyzers.

Related the latrine rumors we heard about troubles with gas analyzers near atomic blasts and in the upper stratosphere near the moon, and launched into a description of our *Aves* line of analyzers including the *Little Giant* at $10.00, the *Handy Dandy* at $20.00, the *Dilly* at $30.00 and the *Acme* at $1500.00.

Fogg's mouth fell open and his lower lip quivered.

"Son, did you say 10, 20 and 30 dollars would purchase a guaranteed-fool-proof-transistorized, digitized and systemated analyzer? Send in a quotation for about 1,000,000 *Dillys;* that name fascinates me." Fogg pushed a button, the chair collapsed under me, the floor opened and whoosh! I found myself out in front of the Pentagon. 1,000,000 *Dillys!* Holy smokes, there aren't that many Harzberg Kanarienvogeln in the whole world. Hey Waldo, what'll we do now?

Panhandle Pete



For
FLUID LINES, CONTROL WIRE GUIDES, THERMOCOUPLE TUBES AND SEPARATORS, PROTECTIVE BUFFERS, ELECTRICAL INSULATION
And Similar Applications Where Only PF Teflon* Can Do The Job

- **extreme temperature service range (-450°F to +500°F)**
- **chemically inert**
- **zero moisture absorption**
- **lowest coefficient of friction of any solid material**
- **rinses clean and does not contaminate**

PF instrument tubing is stress relieved for minimum shrinkage and carefully inspected and controlled dimensionally. A full range of sizes and colors are available to meet your specific needs. Write, wire or call for further information, competent engineering assistance and information on special sizes and walls. PF flexible tubing, heavy-walled tubing and rod stock made from Teflon* is also available.

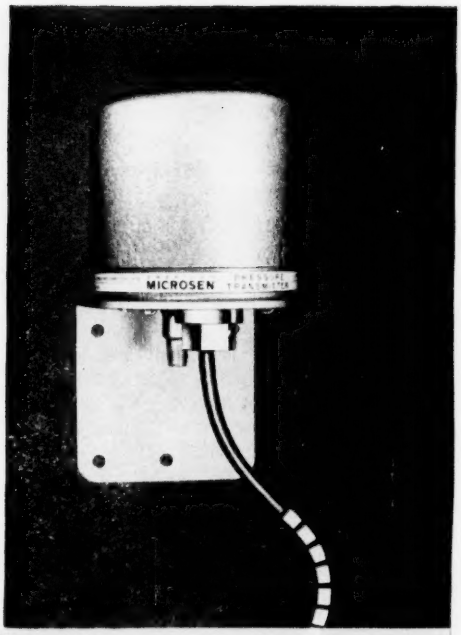
PENNSYLVANIA FLUOROCARBON CO., INC.
1115 N. 38th Street, Philadelphia 4, Pa.
EVergreen 6-0603 TWX PH 252

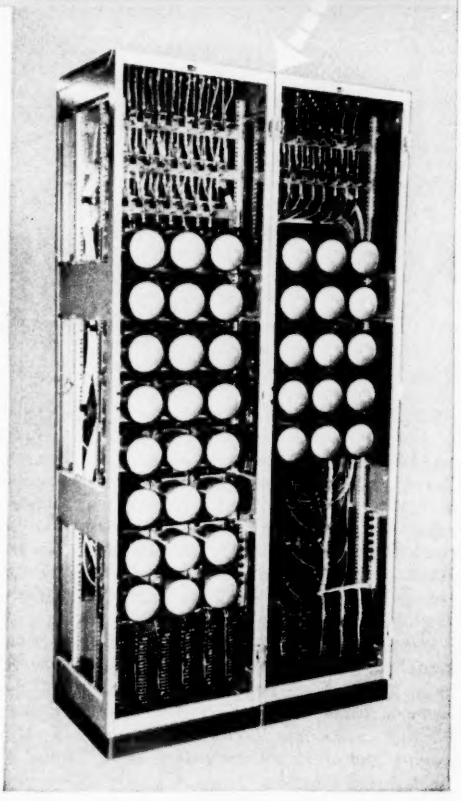
*"Teflon"—Du Pont trade name for Tetrafluoroethylene resin

For more information circle **48** on inquiry card.

NOW... a compact ELECTRO-PNEUMATIC PRESSURE TRANSDUCER

for data reduction systems





The American-Microsen® Series 185 Pressure Transducer is designed to convert pressure signals to dc signals for use with data handling, telemetering or computer equipment. It can be supplied with input ranges from 0-15 psi up to 0-1000 psi; also 3-15 psi to transduce pneumatic signals.

The Series 185 Pressure Transducer converts pressure signals to 1.0 to 5.0 ma. dc which is readily accepted by data handling systems. Sensitivity of the unit is practically infinite. It has a repeatability of 0.3% of span; speed of response is 10 cps.

Use of the Microsen Balance enables the transducer to transmit signals instantaneously over long distances. An external power supply is employed which can be filtered to provide a high signal-to-noise ratio as required in high speed data handling equipment.

Housed in a dust and weatherproof case for universal mounting, the Series 185 Pressure Transducer can be installed on a vertical surface, pipe pedestal or meter piping. It is also readily adaptable to rack mounting as shown at the right. Get detailed information. *Write for Bulletin TP515.*

MANNING MAXWELL & MOORE INC. TRADE MARK

MANNING, MAXWELL & MOORE, INC.

INDUSTRIAL CONTROLS DIVISION · DANBURY, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

For more information circle 49 on inquiry card.

OHIO NITROUS OXIDE

for leak-detection devices

Nitrous oxide, in conjunction with infrared analysis, may provide the answer to your leak detection problem. This method offers a safe, sensitive, clean and flexible means of leak analysis which can be adapted to production line work, as well as single unit testing. Because of its inert properties, nitrous oxide has no effect on components to be tested; and the nitrous oxide infrared method is insensitive to usual atmospheric elements such as moisture, carbon dioxide and hydrocarbons.

Nitrous oxide with infrared determination is now being used successfully in automobile plants and several rubber companies to leak-test air-ride suspension systems and their components. Many other industries are either now — or soon will be — using this method of leak detection. They include such varied applications as: aircraft and missiles, compressors, refrigeration units, process industry piping, tanks, food packaging and air brake systems. May we suggest that you investigate soon the advantages of using nitrous oxide as the detection medium for your leak testing?

Ohio Chemical is the world's largest producer of nitrous oxide. Our 32 branch offices and over 70 warehouse points assure you of nationwide availability.

OHIO NITROUS OXIDE

- ODORLESS AND INERT
- NONTOXIC
- NONCORROSIVE
- NONFLAMMABLE
- ECONOMICAL
- WILL NOT CONTAMINATE TEST PIECES

FREE TECHNICAL AID is available in the use of nitrous oxide for leak detection. For further information, please fill in coupon below requesting the following bulletins:

1A Chemical, Physical and Pharmacological Properties of Nitrous Oxide with Results of Corrosion Tests.

1B Gas Service Equipment for Nitrous Oxide Supply.

"Service is Ohio Chemical's Most Important Commodity"

OHIO
Ohio Chemical
OHIO CHEMICAL & SURGICAL EQUIPMENT CO.
Madison 10, Wisconsin
(A Division of Air Reduction Company, Incorporated) AIRCO

Dept. 1A-11

Please send me Bulletins 1A and 1B, described above.

Firm Name.....

Address.....

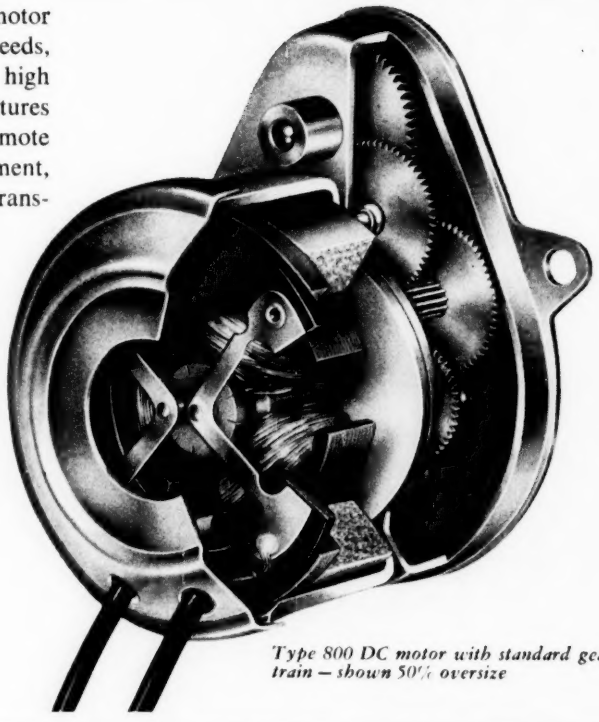
City.....Zone.....State.....

Your Name.....Title.....

For more information circle **50** on inquiry card.

New high-torque low-current DC motor covers extended range of output speeds

The new Cramer Type 800 direct current motor offers an unusually wide range of output speeds, coupled with low current drain, high torque, high efficiency, and excellent speed stability. These features make it the ideal choice for timing devices, remote control equipment, recorders, signalling equipment, communications gear, displays, flashers, chart transports, and many other products.



Type 800 DC motor with standard gear train — shown 50% oversize

Wide Performance Range

Depending on requirements of speed, torque, and voltage, the rotor is wound to produce a basic motor speed of 960 to 3000 rpm. A gear train then reduces this to the speed required at the output shaft. Low rotor speeds result in lower current drain at all speed-torque combinations, but limit the torque available at the higher output speeds. Higher rotor speeds require a somewhat higher input current, but greatly increase the torque available at the higher output speeds.

The Table at lower right illustrates this flexibility of design, with a few examples from the virtually unlimited range of performance characteristics which it provides. Where very low input current is required, and the supply voltage does not exceed 12 volts, the use of the low-speed rotor will provide 30 oz. in. at speeds below 3 rpm and 0.5 oz. in. at 200 rpm. The higher speed rotors meet the requirements of higher input voltages, and provide greatly increased torque at the higher output speeds with only a moderate increase in current drain. The high-torque motor has the additional advantage of speed stability within 10% from no-load to full-load, at speeds below 5 rpm.

The examples given in the Table are for illustration only. By correct choice of rotor winding and gear ratio, an unlimited number of operating specifications can be established throughout the entire range shown. The motor is also available without gear train, for output torques of 0.1 to 0.6 oz. in. at speeds up to 3000 rpm.

OUTPUT SPEEDS WITH GEAR TRAINS	960 RPM ROTOR LOW INPUT CURRENT *(3 to 12 volts DC)*		3000 RPM ROTOR HIGH OUTPUT TORQUE *(3 to 30 volts DC)*	
	INPUT VOLT-AMPERES	OUTPUT TORQUE OZ. IN.	INPUT VOLT-AMPERES	OUTPUT TORQUE OZ. IN.
2 rpd	.16	30	.....	.....
1/6 rpm	.16	30	.56	30
3 rpm	.35	24	.64	30
10 rpm	.35	8.5	1.04	30
30 rpm	.35	3.0	1.72	21
60 rpm	.35	1.5	1.72	12
80 rpm	.35	1.1	1.72	8.5
200 rpm	.35	.5	1.72	3.5
900 rpm	.....	.....	1.90	.8

Typical Performance of Type 800 DC Motors for Minimum Input Current or Maximum Output Torque

Specifications

SPEEDS — 2 rpd to 900 rpm with gear train, 960 rpm to 3000 rpm without gear train.

TORQUE — 0.1 to 0.6 oz. in. without gear train, and to 30 oz. in. with gear train.

CURRENT DRAIN — as low as 30 milliamperes, depending on voltage, load and speed.

VOLTAGES — from 3 to 30 volts DC.

REVERSING OPERATION — with negligible speed difference, because of special motor design.

GEARS — precision-hobbed throughout, totally enclosed and with sealed-in lubricant.

For your free copy of informative Bulletin PB-800, write:

CRAMER CONTROLS
CORPORATION
Box 5, Centerbrook, Connecticut

For more information circle **51** on inquiry card.

NEW Veeder-Root Counters

New Electronic Predetermining Counters

SERIES 1604

These counters are ideal for batch control, sequential predetermining, or accurate length control in such applications as packaging, coil winding, slitting, stacking and material handling.

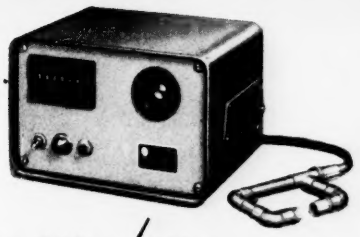
A versatile group of transistorized electronic predetermining counters designed particularly for industrial applications. These units will operate at speeds up to 5,000 counts per second, with automatic recycling at speeds up to 1,000 counts per second. A photohead to actuate the counter can be designed to fit specific applications.

Units can be easily operated by non-technical personnel. The preset quantity can be established quickly at any point within the range of the counter by means of the large selector knobs. Any number of decades can be furnished.

Dual sets of presetting controls for sequential predetermining, or accurate length control in such applications can be furnished on request.

This is your complete package for predetermining counting at high speeds.

For complete details on these units, write today!



Count-PAK

SERIES 1661

Complete electronic counting package for use where high speed, long life and instant reset are required. Highly suitable for high speed direct counting applications such as can and bottle counting or case or piece counting on conveyor lines.

Consists of glow-transfer cold-cathode counting tube and high speed magnetic counter, coupled with transistorized circuits. Photohead designed to your application.

The use of transistors means that heat has been eliminated and no warm up time is required. Unit is completely enclosed in an attractive industrial case to insure long, trouble-free life. Use of an electronic decade increases the life of the electro-mechanical counter and makes the unit ideal for continuous rugged operation.

Write for complete specifications and prices today!

NEW SERIES 1522

High-Speed Predetermining Counter

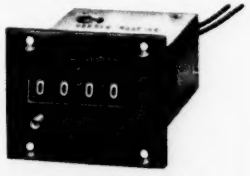
Ideal for high-speed counting requirements such as coil winding, textile spinning frames, and other predetermining counter requirements.

Instant quick-lever reset, plus quick and easy setting of the predetermined number are outstanding features of this counter. Measures approximately 2.6" wide, 5" long, 2.8" high. Speeds up to 6,000 RPM or 8,000 CPM are maximums recommended.

Easily preset to the required number of pieces or performance-units, the counter subtracts to zero. Resetting returns wheels to original preset number. This new counter meets standard U. S. electrical requirements (JIC Codes) . . . and is available with either electrical switch or mechanical stop. Also available without the predetermining feature, as a high speed reset revolution counter.

Also available as a high-speed revolution counter without predetermining feature.

Write for complete information today!



SERIES 1591

Electro-Magnetic Counter

These new compact panel-mounted high speed counters are ideal for D.C. applications requiring accuracy, long life at high speeds and small panel presentation. Counters are suitable for industrial data processing, laboratory and scientific or instrument applications. Available with four or six figures with remote electrical or manual (push button) reset. 3,000 counts per minute recommended speed.

Counters can be connected in series with any device having a contact arrangement. For optimum operation, 60% contact time is required.

Panel Area: 4-figure Counter — 1.7" x 2.1"
6-figure Counter — 1.7" x 2.8"

Available for 6, 12, 24, 48 and 115 volts D.C. operation. For A.C. operation suitable electrical components must be added externally. Reset voltages available are 6, 12, 24, 48, 115 and 230.

Write for complete specifications today!

Veeder-Root
INCORPORATED
HARTFORD 2, CONNECTICUT

For more information circle **52** on inquiry card.

Tubexperience in action

Made to pass the severest tubing test of all

14 different tests have proved it now ready for reactor use

*Superior tubing for applications in the atomic energy field is usually produced to meet highly exacting specifications. A length of tubing like the one shown above may well undergo all the tests and inspections listed here—plus special ones required by the customer.

1. Visual surface check
2. Dimension check (using precision measuring instruments)
3. Hydrostatic test
4. Eddy current inspection
5. Tensile and elongation test
6. Rockwell hardness test
7. Flare & flatten test
8. Dye penetrant (over entire length of tube)
9. Metallographic mount (for checking analysis, temper, grain size and structure)
10. Quantitative and qualitative analysis
11. Corrosion tests (Huey, salt spray, Strauss, autoclave, etc.)
12. Spectroscopic examination
13. X-ray inspection
14. Ultrasonic inspection

We offer many special services, and of our more than 120 available analyses, many are important to atomic tubing users. Equally important are such factors as our ability to produce tubing to extremely close tolerances; the weldability of the stainless and zirconium and nickel base alloy tubing we supply; and our ability to supply stainless alloys and other materials with very closely controlled chemical composition (Type 348, for example, with cobalt held to .10 maximum).

For more information, write us, giving such pertinent facts as the alloys in which you are interested and the end use of the tubing. We will be glad to send you Data Memorandum No. 20, "Tubing for Atomic Power." Write Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company • 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

For more information circle **53** on inquiry card.

THE RW-300

is the first digital computer for automatic process control and data logging

The Ramo-Wooldridge RW-300 Digital Control Computer is available *now* to control process units in oil refineries, chemical plants, and other process industries.

The new RW-300 offers outstanding opportunities for higher profits from existing and future plants—through reduced operating costs, increased throughput and yields, and improved product quality. These benefits will pay back an investment in an RW-300 digital control system within six months to two years.

For technical information on automatic process control and advanced data logging with the RW-300, write: Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P.O. Box 90067, Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY

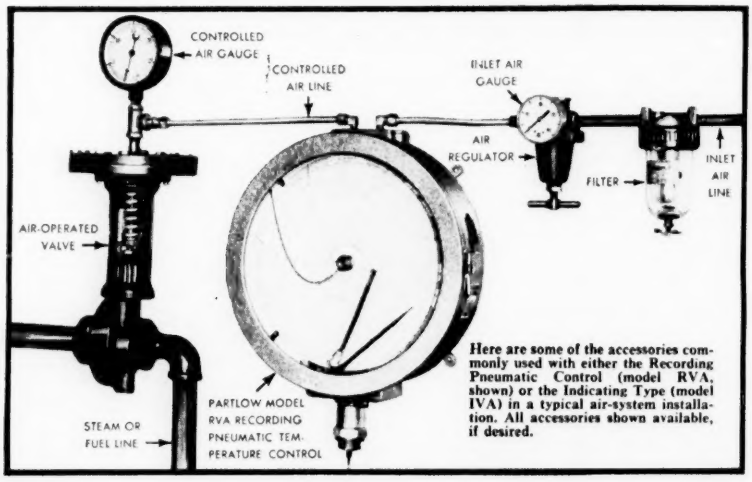
For more information circle **54** on inquiry card.

Introducing . . .

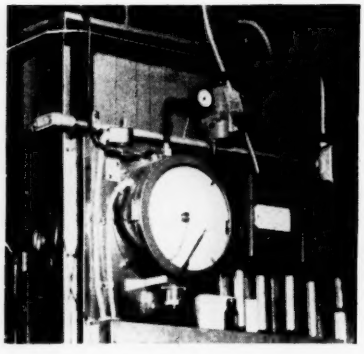
the NEW Partlow Pneumatic Control

New from Partlow . . . throttling-type pneumatic controls engineered to function with extreme accuracy, and sensitivity, under virtually *any* operating conditions.

Actuated as they are by the powerful, direct action of mercury, the Partlow pneumatics actually contain *fewer parts than any other pneumatic control on the market* . . . one reason why they're . . . . **Simpler to install • Simpler to maintain • Simpler to operate • Simpler to replace • and longer lasting, too.**



Here are some of the accessories commonly used with either the Recording Pneumatic Control (model RVA, shown) or the Indicating Type (model IVA) in a typical air-system installation. All accessories shown available, if desired.



MODEL RVA

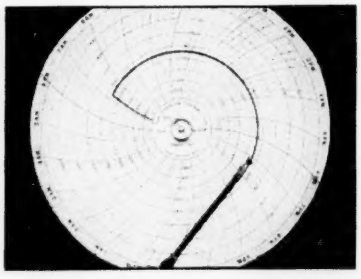
Pneumatic Recording control, installed on new steam-heated cross-flow dryer built by Lydon Bros., Hackensack, N. J.

OUTSTANDING FOR ACCURACY, SENSITIVITY AND FLEXIBILITY

The new Partlow pneumatic controls are accurate to within 1% of scale in any one of 10 ranges from –30° to 1100°F. *Exceptionally sensitive too* . . . providing positive, hair-trigger response even to fractional changes in temperature. *And flexible* . . . with throttling range adjustable anywhere from 3 to 20% of scale range.

COST LESS TO OWN AND OPERATE . . CUT "DOWN TIME" TO A MINIMUM!

Because they contain fewer parts, Partlow pneumatic controls cost less to buy: next to nothing to operate and maintain. *All elements of the same range are interchangeable*, which means they can be replaced right on the job instead of back in the factory . . . 'Down time' is reduced to a matter of minutes. And no expensive inventory of spare parts or spare instruments is ever required.



INSTANT RESPONSE

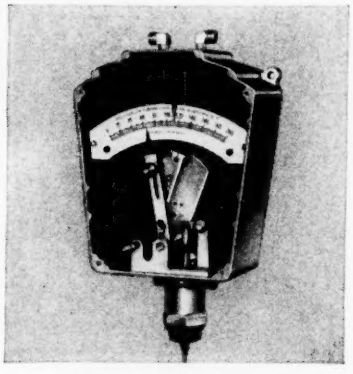
to temperature changes is a key feature of the Partlow pneumatic. Built-in bulb sensitivity teamed with advanced mechanism design means a minimum of saw-toothing on start-up and a fine line of control when the instrument has reached its throttling equilibrium.

IDEAL FOR HAZARDOUS OR 'SHOCK' LOCATIONS!

There are no delicate electronic tubes or gadgets in the Partlow pneumatic to get out of kilter, or possibly trigger an explosion. Its ruggedly simple internal mechanism is virtually shock-and vibration-proof . . provides maximum resistance to moisture, fumes, acid and all types of corrosion. Long-life and trouble-free performance are hallmarks of the pneumatics, as they are of all Partlow controls.

EXCEPTIONALLY VERSATILE TOO!

Both pneumatics — the Recording and the Indicating models — can be used in systems regulating the flow of steam, water or gas . . . or controlling other air-operated devices. Whatever the nature of the heating appliance it actuates, the chances are there's a Partlow pneumatic control to fit your requirements dependably . . . economically . . . *precisely*.



MODEL IVA (interior view)

New Partlow Pneumatic Indicating Control, with throttling range adjustable from 3 to 20%.

SEND US YOUR SPECIFICATIONS

Ask today for a control recommendation tailored for your specific requirements. Of course, if desired, you may field-test this superb new control without cost or obligation. For details write, wire or phone Dept. IA 1158.

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TEMPERATURE CONTROLS

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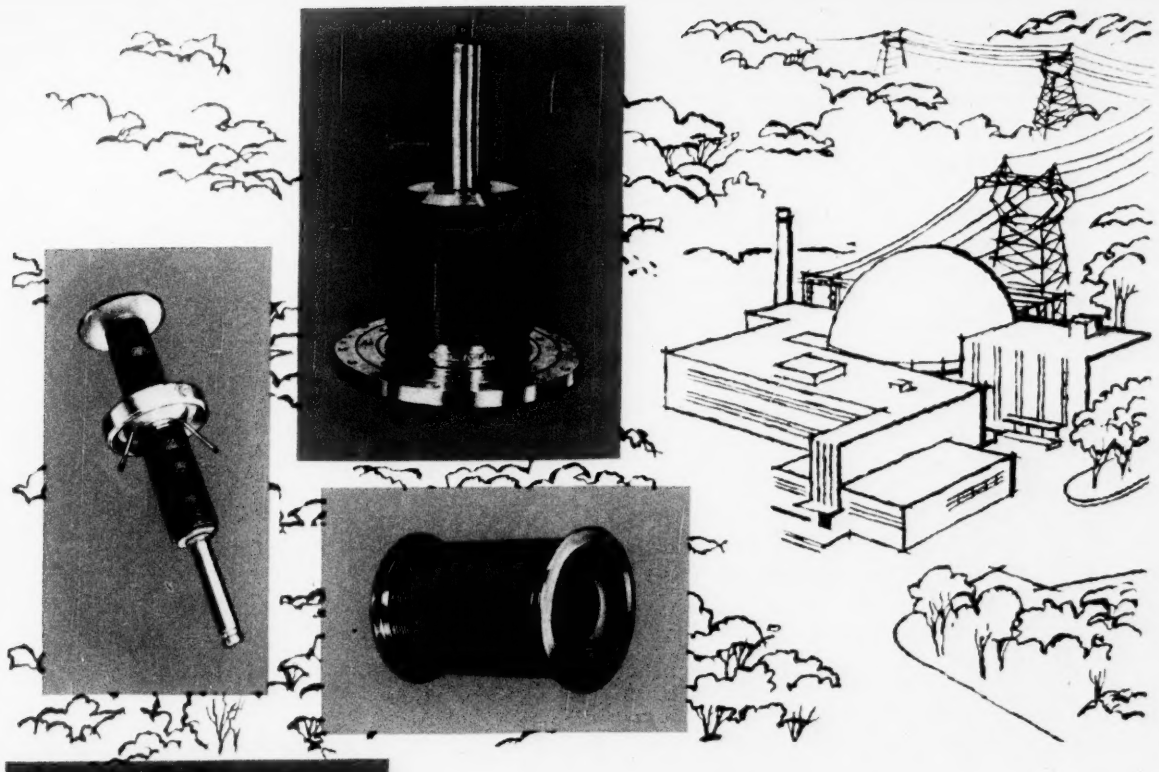

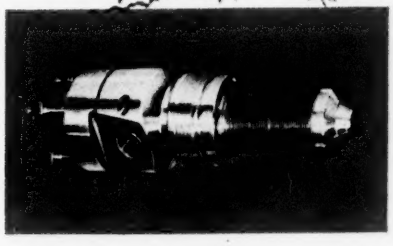

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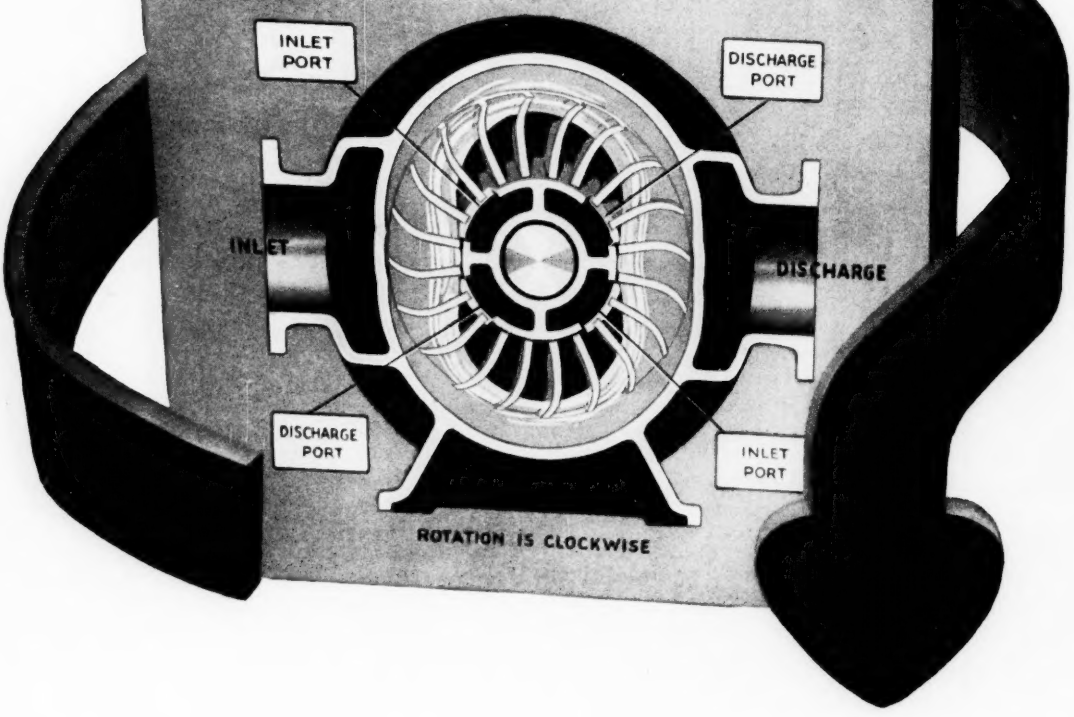

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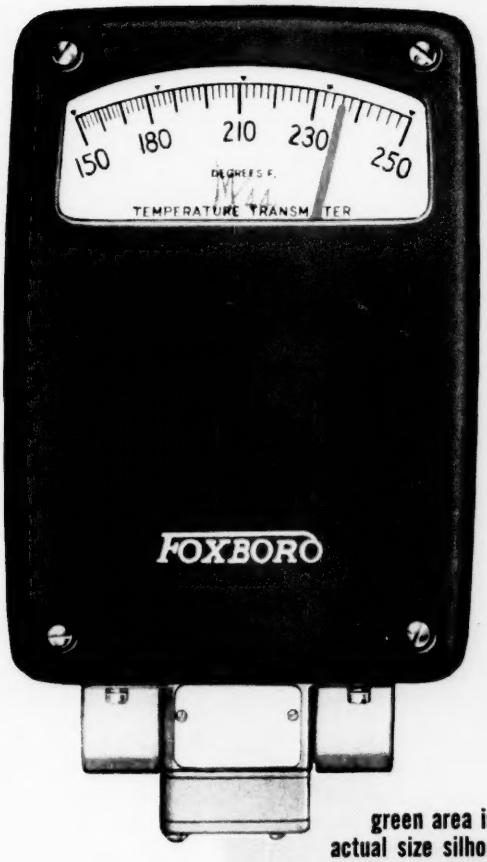

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Here's a brand new instrument engineered specifically for its job of indicating and transmitting temperature.

The M/44 Indicating Temperature Transmitter offers the inherent simplicity of a motion balance instrument. Compact and lightweight (10 lbs.) its indicating scale and fluorescent red pointer are visible up to 20 feet away. The output pressure of the M 44 is transmitted to any remote 3-15 psi recorder, controller, or indicator.

The M/44 is made with standard performance-proved Foxboro components, simply and conveniently arranged in a weather proof steel case. Changing range or type of thermal system can easily be done in your own plant.

Thanks to its rugged construction, the new M/44 is unaffected by vibration, sudden shock, or corrosive atmosphere. Even in the event of air supply failure, this instrument continues to indicate process temperature.

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CHOICE OF THERMAL SYSTEMS

Foxboro M/44 Transmitters are available with any filled thermal system. These classes are suggested for particular range characteristics:

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Lowest cost, fastest response, highest sensitivity. Recommended for all installations within this range except when the measured temperature crosses ambient temperature.

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Good response, good sensitivity, uniform scale. Uses smallest bulb of any filled thermal system.

Class III Gas Pressure (−450° to +1000° F)
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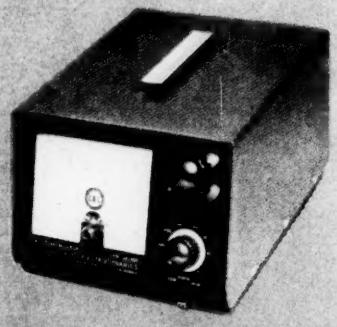

Type 26-302
EXTENDED-RANGE MOISTURE MONITOR
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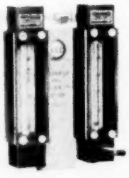

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26-011 Sample By-Pass, 26-013 Sample Vaporizer, and 26-012A Battery Pack Accessories—Bulletin CEC 1848-X10.

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editorial

Needed: *More State Supervisors of Science and Mathematics*

JAMES R. IRVING
Scientific Apparatus Makers Association

OSCAR RIDDLE, a Florida scientist-teacher, writing in a recent issue of *The American Biology Teacher* notes: "The Sputniks and their forebears have eventually engendered a scrutiny that is marvelously late, and almost sure to remain inadequate, hazy and superficial."

The author was referring cynically to the nation's apparent concern for "immediate improvement" in science education "on all levels" sponsored by many who themselves had but a meager concept of what was really needed.

Even today, despite suggestions of crash programs in science, "sweeping revisions of our curriculum" and the "science centered school," little actually is being done. For example, the nation's state departments of education do not, today, accord science and mathematics instruction the same honor and distinction as the school lunch program, driver training, art, music and physical education. In fact, many state superintendents of public instruction see "no particular" reason for supervisors of science and mathematics throughout their state. These are the facts revealed by a recent SAMA study of 48 state departments of education.

TABLE 1—STATEWIDE SUPERVISION OF SCIENCE

State Departments of Education Having Full-Time Science Supervisor(s)	9	Connecticut Florida Georgia Louisiana New Mexico New York North Carolina Pennsylvania Texas
State Departments of Educating Indicating Appointment of Full-Time Science Supervisor by July 1, 1958	2	Kentucky Minnesota[1]
State Departments of Education Using Consultants in Science, Not on State Department Roster	2	New Hampshire[2] Rhode Island[3]
State Departments of Education Showing No Full-Time Science Supervisor	35	

Based on study completed June 1, 1958.

(1). Authorized to add full-time consultant to staff, but not yet appointed when reply to study was made, February 7, 1958.
(2). Uses services of Project Director for New Hampshire Committee for Mathematics and Science.
(3). Uses consultant services of Science Head of Rhode Island College of Education.

In all, only nine states reported a full-time state department staff member—equipped by academic background and experience—assigned to supervise science instruction (Table 1).

Two states were in the process of making such appointments and two were using the services of outside consultants. In one of these two instances, New Hampshire, the supervisor's salary is paid through a grant from a local charitable foundation.

Thirty-five state departments report no full-time supervisors of science and mathematics education.

The state superintendent of a southwestern state doubts the wisdom of having special subject supervisors. "I believe strongly in stressing a wellrounded education program rather than specific subjects," he states.

A western state's Supervisor of Curriculum explains his particular area is under the supervision of a Director of Secondary Education, assisted by a staff of four supervisors. "All of these supervisors are assigned to their duties as generalists responsible for the entire curriculum, rather than as specialists. The only specialists we have in the Department are in the field of Health and Physical Education where we have a Director and a Supervisor."

Many of the 38 state superintendents of public instruction point out that state legislatures do not see fit to appropriate funds for the purpose.

Dr. Howard A. Meyerhoff, Executive Director, Scientific Manpower commission, calls the present situation in our state departments "discouraging." This authority, representing some ten of the nation's most learned scientific groups, points out his discouragement is not so much over the fact that so few state school systems have science supervisors, but because so many state superintendents of education are not convinced of the need for supervision. "It is tragic," says Meyerhoff, "that, under existing circumstances, we must sell so many of them on the need, and that several of those who do give lip service to it are only half-heartedly supporting their request for the necessary appropriation in their legislatures."

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The Scientific Manpower Commission director succinctly sums up the problem by asking a question: "How do we reverse the present situation in which state superintendents wonder how they can justify the hiring of a state supervisor of science education to one in which they will have to justify the failure to have one?"

One of the basic conclusions reached by the country's first Parliament of Science dealt specifically with science supervisors. The more than 100 American scientists and public leaders meeting in Washington last March under the auspices of the American Association for the Advancement of Science recommended that each state have one or more scientifically qualified science consultants or supervisors in departments of public education or universities.

Functions of a State Supervisor

Their functions would be three-fold: They would represent science and scientists in the formation of educational policy; serve as a liaison between scientists and teachers, and collect and distribute helpful instruction information to teachers. The activities and functions of the Supervisor of Science Education, New York State, are listed in Table 2.

Blough and Carleton have called attention to the country's short supply of qualified science teachers, and lack of incentives to inspire teachers. Reduction of teaching loads, improvement of teaching materials, facilities and laboratories, and more time for science teachers for planning and caring for laboratories were stressed by the NSTA officials as necessary to the building and maintenance of an adequate national program of science education.

Many of these dire and immediate needs may well be met by adequate state supervision, designed to aid and upgrade the classroom science teacher.

Private Action

Throughout the country, various private agencies also have taken it upon themselves to aid the classroom science teacher. One such example of direction, help and inspiration is underway in Connecticut. Starting in December 1955, the Research Corporation, New York, undertook an experiment concerned with the teaching of science at the secondary-school level in the state of Connecticut. While the experiment as originally designed is not yet complete, a report of the project to date provides some information that may be of value to those concerned with plans for the betterment of education.

A 3-year program has been established to learn from science teachers themselves their requirements for improving their teaching activities. Under the experimental plan, a representative visits schools throughout the state, asking each science teacher what he or she needs to teach more effectively. The teacher is encouraged to apply for a Research Corporation grant to satisfy his needs.

Preparation of such a statement requires a certain amount of self-evaluation and considerable analytical thought. Frequently composing the statement sets off a chain reaction.

TABLE 2—ACTIVITIES OF A SUPERVISOR OF SCIENCE EDUCATION

"Generally speaking, the duties of this office are to be classified as catalytic. It is our job to do anything within our power to improve science education within the state. A breakdown of some of these activities follows:

1. Supervise the general program of education and especially the teaching of science in the elementary and secondary schools of the State.
2. Supervise the preparation and rating of Regents examinations and other tests in science.
   (a) thirteen Regents examinations (five different sciences) per annum
   (b) nominate outstanding qualified committee members to the examination board
   (c) arrange meetings and accommodations for committees
   (d) work with the editor in preparing final copy
   (e) present examinations to the revisions committee for approval
   (f) construct items to replace those unsatisfactory to the revision committee and/or the editor
3. Supervise the preparation of the science section of the New York State Scholarship examination, Nurse, Math-Engineering and Veterans Scholarship examinations.
   (a) follow the same procedure as with the Regents examinations
      (1) item construction much more difficult because of the function of the examination
4. Serve as a curriculum consultant in the preparation of syllabuses, bulletins, and other materials relating to the teaching of science.
5. Represent the Education Department in the field and at teachers' conferences.
6. Serve as consultant to administrators, teachers, architects and division of Building and Grounds regarding science rooms, equipment and materials.
7. Checks and advises on local courses of study in science.
8. Evaluates books and materials in science education.
9. Conducts Surveys.
10. Speaks at local, county, district zone and state teachers conferences.
11. Serves as consultant to other divisions of the State Education Department and to Civil Service.
12. Acts as a resource person for special committees.
13. Serves on committees of state and national science educators organizations.
14. Acts as local representative of the National Science Teachers Association in the presentation of awards.
15. Assists administrators and teachers in placement.
16. Handles a wide variety of requests from the field.
17. Acts as resource person to State Library.
18. Acts as liaison person with professional societies such as the ACS, APS, American Institute of Physics and other scientific and engineering societies.
19. Acts as liaison person with such groups as the Physical Science Study Committee of the NSF, educational activities of the Atomic Energy Commission within our state."

Hugh Templeton
Supervisor of Science Education
The State Education Department
New York

The program moves slowly. The foundation is at present receiving applications which had their origin in the stimuli applied to teachers a year or more ago. However, meanwhile the attention of individuals, groups, and even communities has been brought to bear constructively on what was needed to improve science teaching in a given school or school system.

In the 2 years that the plan has been in operation, total costs, including all fees and expenses, have amounted to a little less than $20,000. Forty-eight grants have been awarded, amounting to about $50,000. It seems reasonably clear even now that the program has had a profound effect in the state of Connecticut.

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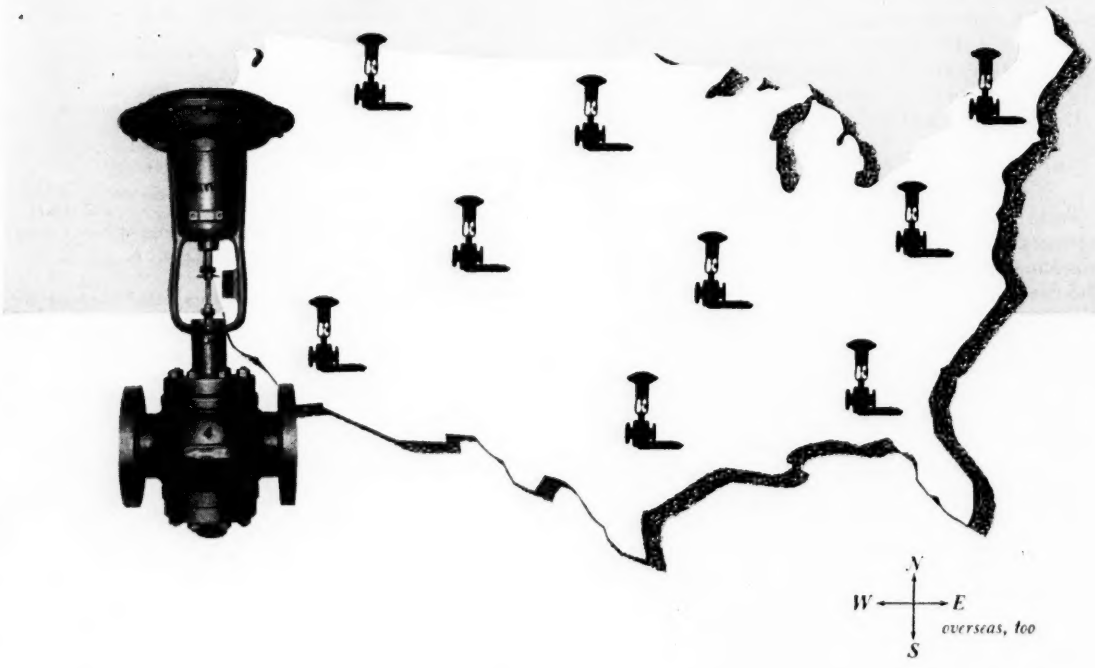

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EDITORIAL—CONTINUED

Another example is the course in "automation" (actually a course in modern engineering physics, electronics and instrumentation) that was developed by 14 technical societies under the guidance of a committee of consultants in Pittsburgh, Pa. Given last year to 56 high-school seniors, it is hoped that the course can be offered also to math-science teachers in the Pittsburgh area, on a night-school basis, next year. (Funds in the amount of $4000 are being sought for this effort.)

Such programs, sponsored and directed by the country's state departments of education, could make an inestimable contribution to the quality and stature of American education in general. This is but one possible approach in our efforts to bolster a well-rounded and comprehensive education for the country's young people. With only nine states out of 48 supporting full-time science supervision—and these people many times overworked out of all proportion to their effectiveness—and 35 states not officially paying any particular attention to science and mathematics in a world of technological discovery and progress, even the most placid exponent of greater attention to science must be more than a little disturbed.

"North Carolina is one of the few states which maintain a science and mathematics adviser in the Department of Public Instruction. The position is thought to be of great worth to the schools and school people of the state in the following ways:

(1) Because of the specialized skills and competencies required in science and mathematics, local classroom teachers and supervisors more readily accept suggestions and direction from a person whose primary concern is mathematics and science.

(2) It places the science and mathematics program on a par with other subject areas such as music, home economics, driver education, etc., which have Department supervisors.

(3) It permits of more effective and direct stimulation and suggestions to schools in improving the ideal science and mathematics program and encouraging the use of promising practices employed by dynamic teachers."

Herbert E. Speece
Adviser in Science and Mathematics
Department of Public Instruction
North Carolina

Simple Math Tools

THE COMPUTING FIELD and many activities relating to data handling and computing seem to have bypassed, or possibly not fully appreciated, an important field which we can call Simple Math Tools, or perhaps Graphical Numerical Computers. The jump from basic, manual computations to elegant electronic computers filled a need caused by a lack of manpower. Yet too often today the large, expensive computer is called upon when a more simple device is indicated. An enormous amount of emphasis is being given to gadgets, push buttons, and flickering lights, and too little emphasis to the design and use of basic, fundamental, simple and inexpensive instruments which can perform many of the same functions, if on a smaller scale.

Large, all-purpose computers and data handlers are required in systems where an automatic memory stores large amounts of information which must be recalled in a short time, or where large storage of information is required, or where many of the same numerical points must be re-evaluated or re-used (as in auto-correlation or function computations), or where masses of data must be handled. Here obviously is an enormous field for automatic computers and these large and expensive instruments are found today in most large laboratories and industries.

Yet many engineers in these laboratories and industries envision the day, which they hope will be in the near future, when their responsibility in computations will be merely to push one button. Ideas even have been expressed on the use of thought waves to simplify the process of pushing this button! Such Utopian ideas and the trend away from the most simple approach to each problem are not healthy or conducive to insight and growth.

Many problems can be solved by an engineer with simple graphical-numerical devices, right at his desk. No one should use an automatic digital or analog computer to multiply two numbers together—yet we have seen engineers in computer groups do just that where only the product of a half dozen numerical values were involved—even when standard and inexpensive automatic desk calculators were on their tables!

There are a large number of mathematical operations which simple devices can perform easier, at lower cost, and even faster than can electronic computers. How many really useful, simple tools are on the market? First is the slide rule, which is basically an analog computer to multiply or divide one number by another; this instrument was invented in the 17th century. Another hand tool is the planimeter, designed a century later for the purpose of graphically integrating an area without resorting to a symbolic system as is necessary in trapezoidal integration. To these there has been added a growing list of mathematical tools, including variable scales, equation finders, curve analyzers, slope readers, function generators, integrators, and differential analyzers. These simple instruments can read curves, normalize data, analyze curves to get the equation, obtain differential (slopes) and integrals (areas) and perform many other basic mathematical functions. This issue is devoted to these mathematical tools, which every technical worker should know thoroughly—*before* he tackles the giant computer.

Soviet Trends in Computers for Control of

A clear and thorough résumé of the state of Soviet computer art, including general-purpose and special-purpose analog computers, network analogs, "programmed and reflection" process control computers, and optimum parameter control computers.

COMPUTER DEVICES are important elements in modern control systems for manufacturing processes. They are also efficient tools for operations research and for study of various industrial processes.

Computer devices comprise a mathematic unit and a logic unit. The mathematic unit is that part of the computer which performs the mathematical operations (quantitative and statistical conversion) connected with the processing of incoming information. The logic unit effects the interpretation (qualitative) of results obtained.

Any device provided either with a mathematic or a logic unit can be regarded as a computer. However, in practice, the physical realization of complex algorithms representing various manufacturing processes requires complicated computing devices.

Paper resulting from Fourth International Automation Exposition, New York, June, 1958.

Applications of computer devices for operations research and automatic control of manufacturing processes

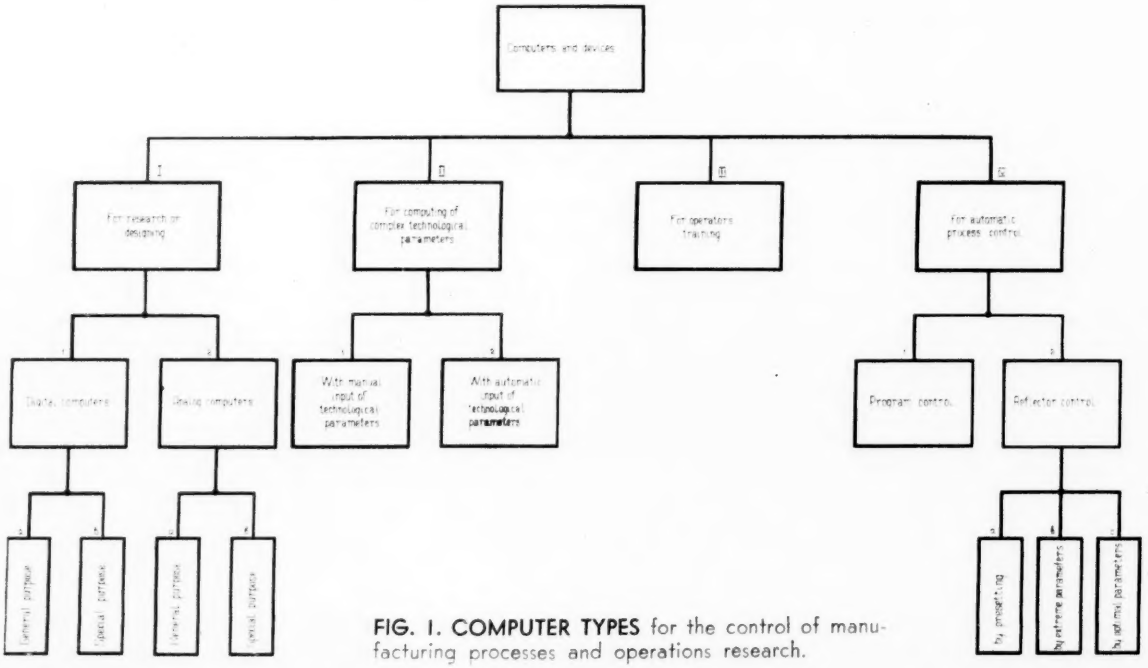

FIG. 1. COMPUTER TYPES for the control of manufacturing processes and operations research.

Manufacturing Processes

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Computer devices can be classified in four main groups (Fig. 1). This report discusses analog computers for research (I-2), computers with manual inputs (II-1), and machines for automatic process control (IV-2).

Group I—Computer Devices for Operations Research and Study of Controllable Processes

Computer devices in this group are used to solve a wide variety of scientific or engineering problems in designing new machinery and units. When high precision of computation is required, digital computers are used—i.e., general-purpose computers of the types "Oural," "M-3," and others; or special-purpose computers, as for example the computer type "Pogoda" (Weather computer). However, the use of large-scale and costly digital computers is mainly restricted either to computing centers or to large scientific and design establishments.

General-purpose analog computers have found broad fields of application in small research laboratories, factories, design offices, high schools, etc. Machines of this class are used widely for designing power plants; for aerial, sea and land transport units; for processing machines and units; for hoisting and industrial transport equipment; in electrical and radio engineering; in construction engineering; in hydraulic engineering, etc. The scope of application of such machines extends also to the field of research in physical and biological phenomena.

In the USSR several types of analog machines are manufactured serially. In addition to the great-scale analog computer Type MN-8 (*MH-8*) designed for solving complex nonlinear ordinary differential equations, several other types of portable small-scale computers are being manufactured, including types MN-7, MN-M, and others. Data on these machines have been published in the technical literature.

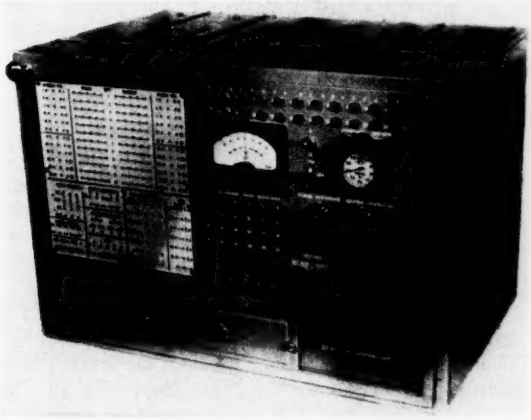


FIG. 2. COMPUTER type MN-10 (MH-10).

The MN-10 Computer

The modern trend in such computer devices is towards higher precision, more logic in the operation control circuit, and wider application of semiconductors not only for nonlinear functional units but also for operational amplifiers and their supplies. The circuits of the first industrial models of computer devices were constructed with radio tubes, but at present, in the USSR, there exists a small-scale nonlinear analog computer type MN-10 (Fig. 2) with a circuit composed of 653 standard semiconductor diodes and triodes. This computer has 24 operational amplifiers and can be used to solve nonlinear ordinary differential equations up to the 6th order, the computer being fed from a 220-volt 50-cps 100-watt supply. The weight of the MN-10 computer is approximately 35 kg, and the area required for its installation on a desk is 0.3 m^2. The computer solves problems with an accuracy not inferior to that of computers using radio tubes.

It should be noted, however, that the logic in the control circuit of the MN-10 computer is developed to a lesser extent than other computers of the same class in which there is possibility of a simultaneous automatic switching-over of some circuits—as, for instance, when equality of two variables is obtained, or one of the variables reaches a predetermined value.

Computer MN-11

The highest class of logic improvement in control circuitry will exist in the new nonlinear analog computer type MN-11, in which the preset solution will be automatically obtained by methods of scanning or minimization.

The aforementioned general-purpose analog computers are designed for solving a great variety of problems in different branches of science and techniques, from aviation and mechanical engineering to chemistry and biology, described by linear or nonlinear ordinary differential equations.

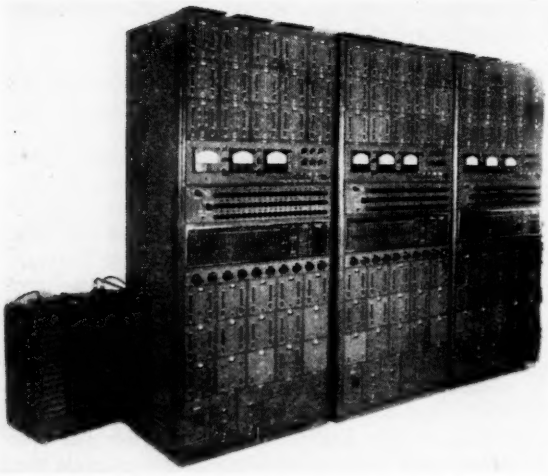


FIG. 3. SPECIAL-PURPOSE electronic simulator type MN-12 (**MH**-12).

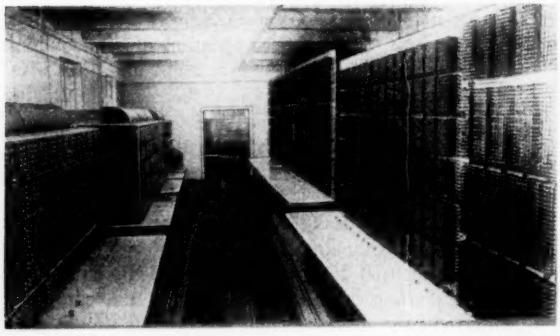


FIG. 4. LARGE-SCALE special-purpose electric network simulator type ZI-S, designed for underground hydraulics problems.

Special-Purpose Analog Computers

In addition to the general-purpose analog computers (Group 1-2-a) there are special-purpose analogs (Groups 1-2-b) such as electric simulators of atomic power systems, power lines, electrical and radio apparatus, engines, rolling mills, metal working machines, chemical reaction vessels and systems, hydrosystems, transport means, and even biological systems.

Type MN-12

The nonlinear electronic simulator type MN-12 (Fig. 3) is an example of a special-purpose analog computer designed for studying the dynamics of a continuous three-high cold rolling mill. This simulator represents phenomena taking place in the main drives of the stands of automatically controlled rolling mills during the rolling process. Account is taken of the peculiar conditions of reduction in gage at each stand, and the tension between the stands during the process.

The cycle of threading speed to running speed, back to threading speed, and stoppage of the rolling mill is also simulated by the MN-12. The simulator comprises three similar analog sections; the number of sections may vary to suit the number of the rolling-mill stands.

Each section comprises 10 integrators, 20 summers, 12 invertors, 2 generators of functions of time, 4 multipliers, 6 generators of different transfer characteristics, 1 unit of variable time delay, 1 generator of saturation and of hyperbolic curves, and 2 function generators of one variable (that may be also used for obtaining nonlinear characteristics of servomechanisms). The separate units of the MH-12 are designed on the same principles as those of general-purpose analog computers.

Network Analogs

In the second important class of analog computers may be placed electric simulators designed for studying systems described by differential equations in partial derivatives. Special-purpose machines in this class are serially produced in the USSR including the small-scale electric-network analogs model ZI-12 for 448 nodes.

Within the network class, and of greater importance, are the special-purpose electric network analogs, the largest of which is the unique analog model ZI-S, specially designed for the investigation of underground hydraulics problems connected with an efficient exploitation of oil fields (Fig. 4). This analog is used in the All-Union Scientific Research Oil-Gas Institute under the guidance of Prof. Belash. It solves problems in the design and exploitation of large oil fields (with a radius up to 120 km) with oil zones of different configuration, or of groups of oil fields connected by hydrodynamic bonds.

These problems may concern oil zones in steady state (at water pressure) or unsteady state (elastic) and are described by equations of Laplace:

$$\frac{\partial}{\partial x}\left[A_1\ (x,y)\ \frac{\partial P}{\partial x}\right]+\frac{\partial}{\partial y}\left[A_2\ (x,y)\ \frac{\partial P}{\partial y}\right]=0$$

and Fourier:

$$\frac{\partial}{\partial x}\left[A_1\ (x,y)\ \frac{\partial P}{\partial x}\right]+\frac{\partial}{\partial y}\left[A_2\ (x,y)\ \frac{\partial P}{\partial y}\right]=A\ (x,y)\ \frac{\partial P}{\partial t}$$

at boundary conditions of the I and II kind, constant or variable in time, and with zero (or differing from zero) initial conditions. In the equations, P = pressure inside the layers; x, y = coordinates; A_1, A_2, etc. = conductivities.

The boundaries of the problems solved by the ZI-C computer may have different configuration, and the boundary conditions are set for both the exterior and the interior contours of the boundary. Considering that more than 30,000 parameters must be simultaneously stored for solving such problems, the applica-

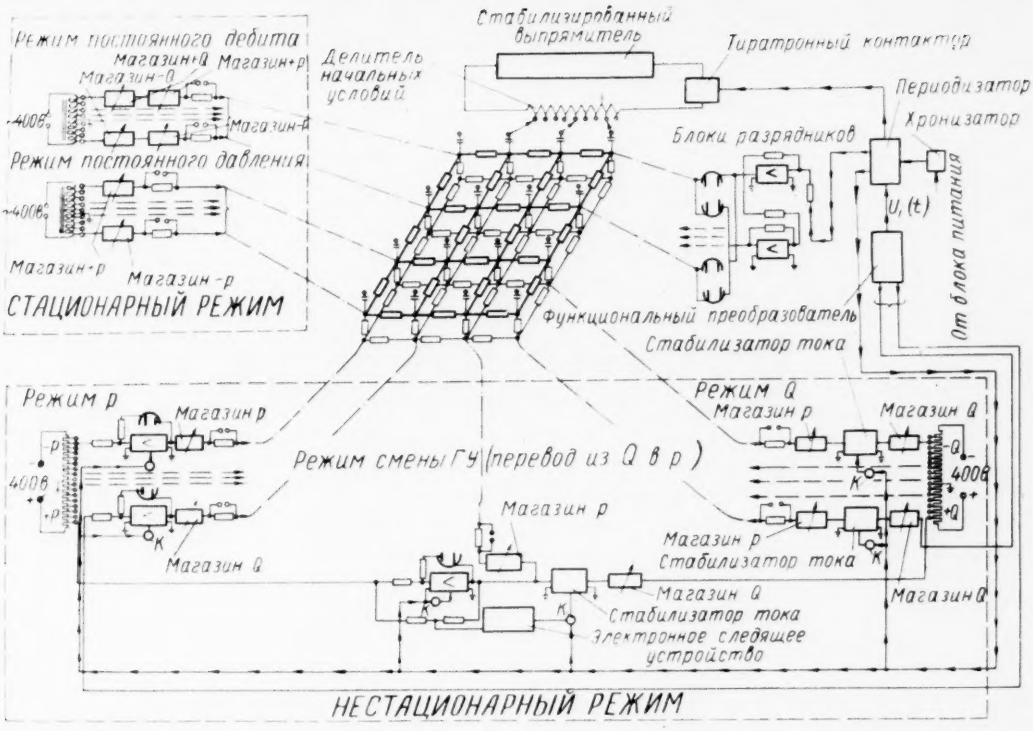


FIG. 5. BLOCK DIAGRAM of the computer type ZI-S. Block at upper left shows "steady state regime"; block at bottom shows "unsteady state regime."

tion of general-purpose digital computers has met with difficulties. This has stimulated the construction of the analog-computer type ZI-S, designed in the form of a three-dimensional network composed of active resistors and capacitors. The block-diagram of the ZI-S computer (Fig. 5) illustrates the main principles of commutation for simulation at steady and unsteady states.

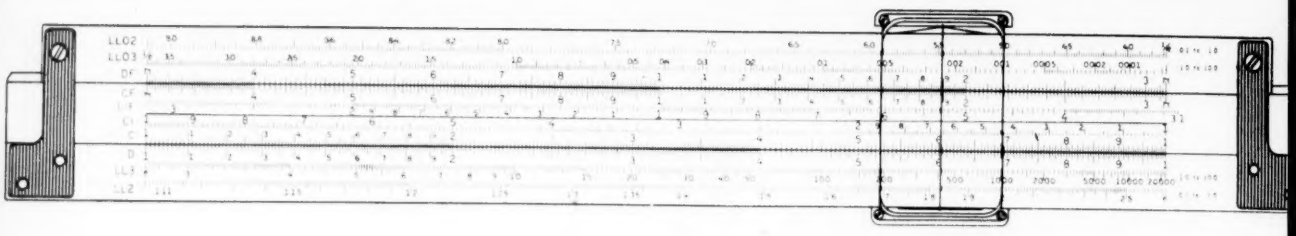
The investigated boundary of the problem is simulated by a network of active resistors with approximately 20,000 nodes. The network is divided into three zones. The spacing in the exterior zone is four times as great as in the middle zone, and eight times as great as in the central zone network. The central (interior) zone of the network usually simulates the oil zones; the middle and exterior ones simulate the adjacent water-bearing strata. The elastic capacity of the zone is simulated by means of capacitors connected to the network nodes.

The computer allows the setting of first and second kind (pressure and yield) boundary conditions over 750 channels (500 with positive and 250 with negative sign). In the course of solving a problem, each boundary condition can be automatically switched on or off in accordance with the time diagram. When the function sought for reaches the preset value the boundary conditions also may be switched over from the second kind (yield) to the first kind (pressure) according to the program; 50 boundary conditions can be variable in time. Thus, simultaneously, the operation of 750 oil wells under different conditions can be simulated.

For simulation of unsteady-state problems described by the Fourier equation, the solution is periodically reproduced at a frequency of 4-8 cycles and is displayed, in the form of curves, on the screen of an electronic indicator.

For simulation of steady-state problems the solution (voltage at nodes) is automatically indicated. The computer is to be equipped with an auxiliary automatic plotter of isometric lines. The ZI-S computer has a maximum power consumption of about 60 kw and is constructed with approximately 8,000 radio tubes. The area required for its installation is from 150 to 200 m^2. It is serviced by 6 or 8 operators. The computer allows easy modification of the problem conditions and, owing to rapidity of action, makes it possible to closely observe the changes occurring in the solution of the problem. This is essential in determining the optimal number and disposition of oil wells and their mode of operation. Simulation leads, as a rule, to a reduction of the total number of active and injection oil wells and, consequently, to smaller investments. An increase of the total oil production from the oil fields at the expense of nondrained areas may be from 5 to 7%, and the determination of optimum conditions for flooding beyond the outline (contour) brings about a considerable saving in exploitation costs and increases the yield of operating oil wells.

Next month: This survey continues with computers for process parameters, training of process operators, and automatic process control.



SLIDE RULES

The slide rule is still the basic mathematical tool for the average engineer. Knowledge of each scale permits the flexibility of the rule to be put to best advantage—with practice.

M. H. ARONSON

THE SLIDE RULE is a mathematical tool for performing many arithmetic and trigonometric computations rapidly. With a good 10″ rule, accuracy of 0.1% is attainable.

To the base 10, the logarithms of the numbers 1 to 10 are as follows:

log 1 = 0.00000	log 6 = 0.77815
log 2 = 0.30103	log 7 = 0.84510
log 3 = 0.47712	log 8 = 0.90309
log 4 = 0.60206	log 9 = 0.95424
log 5 = 0.69897	log 10 = 1.00000

The L, C and D Scales

If a 10″ rule is marked off in the same ratio as these numbers (that is, the left or 0″ edge marked 1; the 3.01″ point marked 2; the 4.77″ point marked 3; etc.) we have the L and D scales of a slide rule (Fig. 1).

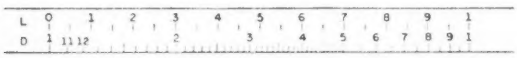


FIG. 1. The L and D scales.

The L scale gives the *logarithm* of any number on the D scale; the D scale is a scale whose *distances* represent the logarithms of the numbers on it.

In order to multiply two numbers expressed logarithmically, it is only necessary to add their logarithms. The result is the product expressed logarithmically. Similarly, division is a subtraction process.

By using two scales marked like the D scale, the logarithms (distances) are easily added or subtracted. The result (another distance) gives the product or quotient. The second D scale is called a C scale. The C and D scales are the basic multiplication and division scales. To multiply, the index of the C scale is placed over the number to be multiplied; the reading is taken from the D scale; to divide, the numerator (on the D scale) is located under the denominator (on the C scale). It is easily seen that distances are subtracted by this process.

Inverted Scales

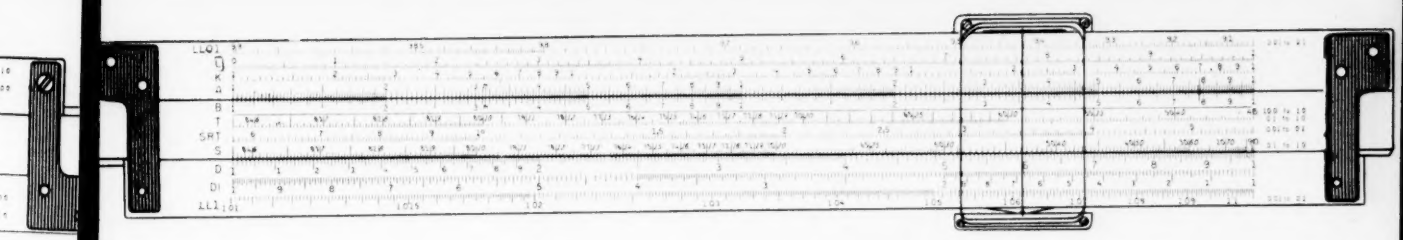
An inverted C scale (CI scale) is simply a C scale with markings that progress from right to left rather than from left to right. It will be seen from a rule that to add distances on the CI scale to those on the D scale (that is, to multiply) the two numbers to be multiplied must be placed one on top of the other (as was done for division when using the C and D scales). Similarly, division is done via the CI scale by using the "multiplication" technique of the C and D scale.

The reason for this is found when it is desired to divide a given number by several other numbers. By setting the index of the CI scale on the given number, division by any number involves only a motion of the slider without any motion of the CI scale.

Folded Scales

The CF and DF scales are "folded" scales. That is, they are C and D scales with the index located approximately at the center of the rule rather than at the edge. As the pi point is approximately one half of the total rule distance, this point is chosen as the place to "fold" the C and D scales for a reason which will be obvious in a moment.

Since the C and D scales are exactly like the CF and DF scales, the ratio between any two numbers on the former (a C number located over a D number) is the same not only elsewhere on the C and D scales but also anywhere on the CF-DF scales. This means



that answers found on the D scale also can be found on the DF scale. As the DF scale is folded, if the number sought on the D scale falls outside the scale, it will be found on the DF scale without resetting the sliding scale. For example, to multiply 2×6, if the left index of the C scale is set on the 2, the result cannot be found on the D scale, but it will be found above CF-6 on the DF scale.

Thus when the answer to a multiplication problem falls outside the D scale when using the C-D scales, find the answer on the DF scale.

Note that pi on the DF scale is above the index of the D scale. Similarly, every number on the DF scale is pi times the corresponding number on the D scale. The DF scale yields the pi product automatically. Note that the same is true of the CF and C scales; any number on the former is pi times the corresponding number on the C scale.

Reciprocals

The CI and CIF scales are inverted (reversed) C and CF scales. Thus any number on the CI scale is the reciprocal of any number on the C scale and vice versa. The CIF scale shows the reciprocals of the CF scale, and vice versa.

Squares and Square Roots

The A scale carries the square of numbers on the D scale. (Similarly the B scale carries the squares of numbers on the C scale.) We can square numbers by moving from D to A, and find square root by going from A to D, under the hairline. Similarly the B scale is the square of the C scale.

If the A or B scales are used during the course of multiplying and dividing in a fraction series, caution is needed lest the operator square the entire fraction rather than the number specified. In the problem $(85)(61)^2/300$, the hairline is set on 85 on the D scale and the slider is moved to bring up 3 on the C scale into coincidence. Then, if the hairline is moved to 61 on the C scale and the rule is turned to read from the hairline on the B scale, the operator has made a plausible mistake; instead of the given problem he has found $(85 \times 61)^2/300$.

Let us see how to avoid this pitfall. For simple problems, like the one given, first square the term (61), then perform the rest of the calculation on the A and B scales.

Table I—Basic Slide-Rule Scales

SCALE	DESCRIPTION	BASIC USES
L	Log scale.	Gives logarithm to base 10 of any number on C or D scale.
C, D	Basic scale in which distances represent logarithms of number on scale.	Multiplication and division; D also gives log. of numbers on LL scale. Used with most other scales.
CF, DF	Folded scales. Same as C and D except index (starting point) is near center of rule. Pi is chosen as place of fold.	Same uses as C and D scale. When answer is "off" scale when using C and D, answer can be found on CF and DF. Also, any number on CF is pi times C; any number on DF if pi times D.
CI, DI, CIF	Inverted (right-to-left) C, D, or CF scale.	CI gives reciprocal of any number on C directly; CIF does same for CF numbers; DI does same for D numbers.
A, B	Square scale.	A contains square of any number on D; B contains square of any number on C.
K	Cube scale.	K contains cube of any number on C (or C contains cube root of number on K).
LL1, LL2, LL3	Log log scales giving e^n where n is between 0.01 and 0.1 (LL1), between 0.1 and 1.0 (LL2) and between 1.0 and 10.0 (LL3).	Gives e^n directly where n is any number on D scale. Used with C scale to find any number raised to any power.
LL01, LL02, LL03	Reciprocals of LL scales.	Gives e^{-n} where n is a number on D scale. Used with C scale to give any number raised to any negative power.
S	Sines and cosines of angles.	C or D scale gives sine of angles marked in black on S scale; C or D scale shows cosine of red angles on S scale.
ST	Expanded S scale for small angles (less than 5.7°).	Same as S except sines values are between 0.01 and 0.1. Also gives cosines of large angles.
T	Tangent scale.	D or C scales give tangents of angles marked in black on T scale; DI or CI scale gives tangents for angles marked in red.
Sh	Hyperbolic sine.	D or C gives sinh of any number on Sh scale.
Th	Hyperbolic Tangent.	D or C gives tanh of any number on Th scale.

FIG. 3. Flow slide rule. (Courtesy The Foxboro Co.)

The A and B scales have two identical halves. It is important to use the correct half when finding square roots from the A or B scale to the D or C scale. If the original number is between 1 and 10, start from the left half; if it is between 10 and 100, start from the right half. For other numbers, move the decimal point an even number of places to get the number between 1 and 100, then select the scale half by the above rule. When the answer is found, return the decimal point, but only half the number of places it was moved originally.

Cubes and Cube Roots

The K scale is the cube of the D scale. There should be no difficulty in cubing from D to K, but the operator must start from the *correct* one of the three parts of the K scale when finding cube roots. Use the left part for numbers from 1 to 10; use the center section for numbers from 10 to 100; use the right part for numbers from 100 to 1000. For other numbers, move the decimal point in multiples of three places to get it between 1 and 1000. Select the proper part of the K scale, find the answer, and return the decimal point one place for every three it was moved originally.

Logarithms

The L scale gives logarithms (the mantissa only) to the base 10 of numbers on the D scale; the D scale is the antilog of the L scale.

Log Log Scales

The *log log scales* are scales giving e^n, where e is the base of natural logarithms, and n is any given number on the D scale. The LL3 scale gives e^n for n between 1 and 10; the LL2 scale gives e^n for n between 0.1 and 1.0; LL1 scale gives e^n for n between 0.01 and 0.1. Note that this represents a range of numbers from 1.01 to above 20,000.

These valuable scales permit rapid finding of any number raised to any power, including fractional and non-integer powers.

For example, $5.5^{1.4}$ power is found simply by use of LL3 and C scale. Setting index of C scale on LL3 5.5, the answer (12.85) is read from the LL3 scale under 1.4 on the C scale. Of course the CF scale can be used instead of the C scale, as has been described previously.

The LL1, LL2 and LL3 scales are usually accompanied with scales marked LL01, LL02, and LL03. The LL0 scales are simply reciprocals of the corresponding LL scales—that is, the LL01 is the reciprocal of the LL1, etc.

These scales can be used to find reciprocals. Also, they give e^{-n} directly because the LL scales are scales of e^n (remembering that n is any number on the D scale).

It is obvious that the D scale gives logarithm (to the base e) of any number on the LL scale.

Practice is essential for efficient use of these scales; and attention must be paid to proper location of the decimal point in all slide-rule calculations.

Functions of Angles

The S, ST and T scales are marked in angles. To find the sine of an angle, set the hairline over the angle using the black marks on the S scale. The sine is on the D scale.

When the angles marked in red are used, the D scale shows the cosine.

The ST scale expands readings across the rule for small angles (0.57° to 5.74°). The sine values are from 0.01 to 0.1; *this must be remembered* when placing the decimal point when starting from the ST scale.

Cosines of large angles are found by converting cos A = sin (90° —A) and using the ST scale to find the sine of the small angle.

Use the T (tangent) scale to find tangents of angles. The T scale runs from 5.7° up to 45° in black, then returns in red for angles from 45° to 84°. Therefore, for angles up to 45°, use the angles marked in black and read the tangent number on the D scale. for angles over 45°, find the angle in red on the T scale and the tangent on the D1 (or C1) scale. Cotangents are found by equating cot A = 1/tan A, or cot A = tan (90°—A) first, and then working with the T scale.

The T scale is not useful for finding tangents less than 0.1 (angles less than 5.71°), or for tangents greater than 10 (angles greater than 84.29°). It can be shown that the tangent for these very small and very large angles equals the sine to a good first approximation.

Special Slide Rules

Rules are available with many other scales tailored to specific uses, as in quality control, where certain mathematical functions are used consistently. Many of these various rules can be applied in allied fields.

One useful slide-rule configuration is the circular slide rule in which all the conventional scales are arranged circumferentially around a disc, rather than lengthwise. The basic advantage of this construction is that the rider and answer point can never be "off scale," as can happen in a conventional slide rule.

Many special slide rules are available with scales that give number of concrete blocks for a given wall size and height; percent profit for any given cost and selling price; pump size for given head, capacity and friction losses; heating and air-conditioning BTU's required for various room sizes, constructions, and temperatures; cubic yards of concrete versus various volumes; and many, many more. Fig. 3 shows a *flow slide rule* for calculating rate of flow and differentials across orifices, and for calculating orifice bores, venturi throats, etc.

Use of the Slide Rule

Proper use of the slide rule requires practice with typical problems. Decimal points must be considered carefully.

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PROBLEMS on the slide rule can include working with the number, with logarithms to the base 10 (logs) or logarithms to the base e (ln's). Note: a logarithm to the base e (ln) is 2.3 times the log to the base 10.

Multiplication and Division

The principle involved in multiplication is the addition of the logarithmic distances of the numbers to be multiplied. Division is the subtraction of these logarithmic distances. Applying the above principles to the simple problem of 2 x 2 we set the 1 index (origin) of the C scale over 2 on the D scale, i.e. 30.1% of the length of the D scale. Now move the rider (hairline) down to 2 on the C scale, which is also 30.1% of the length of this scale. We have now traversed a total of 60.2% of the length of the D scale. We have added logarithms, effectively, and read 4 on the D scale. Let us apply these principles (unconsciously) to a more general problem, finding the answer for 15 x 2.5 x 173.

Place the C index over 15 on the D scale. Move the rider hairline to 25 on the C scale, then move the slide so the C index is under the hairline. Finally move the rider to 173 on the C scale. We have added logarithmically calibrated lengths. The answer is 6485, read on the D scale. As 15 x 2.5 is roughly 40, and 40 times 200 is about 8000, the decimal point is after the fourth digit.

Divide 580 by 78 (the answer is about 7 by inspection). Place the rider over 580 on the D scale and push the scale so that 68 on the C scale also is under the hairline. The answer is under the 10 index on the C scale. Note that we have subtracted logarithmic lengths. The answer is 7.44.

We will add and subtract logarithmic lengths to solve the following:

$$\frac{\underset{f}{4283} \times \underset{g}{2756} \times \underset{h}{492} \times \underset{i}{58475}}{\underset{a}{623} \times \underset{b}{5970} \times \underset{c}{39856} \times \underset{d}{139.2} \times \underset{e}{7586}}$$

One must first perform a quick cancellation in order to find the magnitude of the answer. Proceeding from left to right, a will go into f 7 times, 7 into b 800 times, 800 into g 3 times, 3 into c 13000 times, h into 13000 26 times, 26 into i 2000 times, 2000 into e 3 times, and 3 times d = 400 approximately.

Set the hairline at 623 on the D scale, move the slide so that 4283 on the C scale is over it, move the rider to 5970 on C, pull the slide to 2756, move the rider to 139.2, push the slide to 492, move the rider to 39856, move the slide to 58475, move the rider to 7586. The answer is on the D scale —461.

In multiplication and division the manual operations can be shortened by using the CF and DF scales in conjunction with the C and D scales. The numbers on the CF and DF scales are simply pi times the numbers on the C and D scales; the 1 index is in the middle of the ruler on these two scales.

In the problem 325 x 11 x 4/430 x 25, set 325 on the D scale, divide it by 430 using the C scale. The number 11 is not in an operating position on the C scale so we move the rider to 11 on the CF scale. Then move the slide so 25 on the CF scale is under the hairline. Then move the rider to 4 on the *C scale*, because 4 is not in an operating position on the CF scale and we must return to the D scale for our final reading. The answer is 1.33.

Practice problems:

$$\frac{425 \times 982 \times 756 \times 319 \times 126 \times 82}{139 \times 557 \times 639 \times 247 \times 345} = 246.7$$

$$\frac{835 \times 119 \times 490 \times 129 \times 95 \times 215}{36 \times 290 \times 52 \times 678 \times 473 \times 75} = 9.82$$

Logarithms

We shall discuss the base 10 system first. In taking the log of any number, reduce the number to the *standard state*, i.e. one digit times a power of ten. Thus 0.000,592.3 $= 5.92 \times 10^{-4}$; $2.838 = 2.84 \times 10^{3}$; 8,548,000,000 is 8.55×10^{9}. The log of 10^{x} is x. Now set the number on the D scale and its log is read directly on the log (L)

scale. Add this to x (plus or minus) and you have the answer.

Examples:

1) $\log 5{,}743{,}000{,}000 = \log 5.74 \times 10^9$
$= 0.759 + 9 = 9.759$

2) $\log 0.000{,}003{,}472 = \log 3.47 \times 10^{-6}$
$= 0.928 + (-6) = -5.072$

3) $\log 4852 = \log 4.85 \times 10^3 = 0.686 + 3 = 3.686$

To take antilogarithms, use the reverse procedure. Set the positive mantissa on the log scale and find the number on the D (or C) scale.

$\log x = 5.48$, find x

Set 0.48 on the *log* (L) scale. Read 3.02 on the D scale. Therefore x is 3.02×10^5.

$\log x = -4.76$, find x

$\log x = -4.76 = 0.24 + (-5)$

Set 0.24 on log scale. Read 1.74 on D scale. Therefore x is 1.74×10^{-5}.

Natural Logarithms

Operate from the LL scales (LL1, LL2, LL3, LL01, LL02, LL03) toward the D scale. The decimal point is either marked at the right-hand end of the appropriate LL scale or it can be easily figured out from noting that the answer must be between 1 and 10 on the LL3 scale (that is, the scale carries e^1 to e^{10}). From this fact it is seen that the answer must be between 0.1 and 1.0 when using the LL2 scale; between 0.01 and 0.1 when using the LL1 scale; between -1.0 and -10.0 when using the LL03 scale; between -0.1 and -1.0 when using the LL02 scale; between -0.01 and -0.1 when using the LL01 scale.

However, from the LL scales, it can be seen that the ln of numbers only above 1.01 and less than 0.990 are given directly. Hence the following rule must be remembered to cover numbers not on the LL scales:

The ln of any number between 1.001 and 1.01 (or between 0.999 and 0.990) is found by subtracting 1 from that number.

Example: ln 1.0015 is 0.0015; ln 0.9985 is -0.0015; ln 0.9956 is -0.0044

To find the ln of any number greater than 10,000 first reduce the number to a standard number—i.e., 289,000,000,000 is 2.89×10^{11}. The ln of 2.89 is 1.06 and the ln of 10^{11} is 2.3 x 11 or 25.3. Therefore the answer is 26.36.

To find the ln of any decimal smaller than 0.001, for example 0.000,000,856: Write the decimal as 8.56×10^{-7}. As explained, the ln of 8.56 is +2.148 and the ln of 10^{-7} is $(2.3)(-7)$ or -16.1. Therefore the ln is -13.952.

Antilogarithms, Base e

The antilogarithm is found by the reverse procedure:

Find x when $\ln x = -39.28$.

$39.28/2.3 = 17.08 = 0.92 + (-18.0)$.

The antilogarithm (base 10) of -18 is 10^{-18}.

The antilogarithm (base 10) of $+0.92$ is 8.3

Therefore, $x = 8.3 \times 10^{-18}$

Example 2: Find x if $\ln x = -8.56$.

Set 8.56 on D; x (on LL03) = 0.000192

Example 3: Find x if $\ln x = 5.92$.

Set 5.92 on D, x (on LL3) = 374

Example 4: Find T if $\ln (T/300) = -0.35$.

$T/300 = 0.705$

$T = 211.5$

Powers and Roots

Powers and roots of numbers can be taken by multiplying the logarithm of the number by the power (or dividing by the root) then finding the antilogarithm. One can go to either the base 10 log using L and C scales, or natural log (ln) using LL and D scales, as follows:

Example 1: $(2.87)^2$

ln 2.87 = 1.05 (from LL3 and D)

1.05 x 2 = 2.1

antiln 2.1 = 8.2 (from D and LL3)

Example 2: $(187)^{5.6}$

ln 187 = 5.22 (from LL3 and D)

5.6 x 5.22 = 29.3

Antiln 29.3 = antilog 12.72, or $(0.72 + 12)$
$= 5.25 \times 10^{12}$ (from L and C)

Example 3: Find 3.5th root of 42, or $42^{1/3.5}$

ln 42 = 3.74 (from LL3 and D)

3.74/3.5 = 1.07

antiln of 1.07 = 2.9 (from D and LL3)

A second and more rapid technique for raising a number to any power is to use the LL and C scales. Let us do example 3 above, or $(42)^{1/3.5}$:

Set 42 on LL3 scale. Place C 3.5 over it; move rider to index on C; read answer 2.9 on LL3.

To do example 1—2.87^2—by this technique:

Set 2.87 on LL3; set C index over 2.87 on LL3; move rider to C-2; read answer 8.2 on LL3.

The answer to $5^{-2.6}$ is read on LL03 scale, or 0.0152.

The number $e^{3.25}$ is simply another number raised to a power. Since e is under the 1 index of D, set the rider at 3.25 on D scale, answer is 25.8: $e^{3.25} = 1.384$ on scale LL2; $e^{0.0325} = 1.033$, see scale LL1; $e^{0.000325} = 0.0325$; $e^{-3.25} = 0.0388$; $e^{-.325} = .722$, see LL02 scale; $e^{-0.0325} = 0.968$; $e^{-.00325} = 0.99675$.

Trigonometric Functions

Angles are set on scales T, ST, and S, and the trigonometric function read on the D (or Trig) scale. As the sine and tangent of all angles up to 5.7° are practically the same, set the angle on the ST scale and read the answer on the Trig scale, pointing off as 0.01 to 0.1.

Sine of 2.5° is 0.0436 and the tan is 0.0436. The sine of 11.9° is 0.206. The tangent of 16.4° is 0.294; the tan of 20° is 0.364.

The tangents of angles greater than 45° are read on the CI scale. Thus tangent of 75° is 3.74 and of 83° is 8.15 and of 88.5° is 38.2.

In order to find the cosine of an angle set the angle on the S scale reading from right to left. Thus cosine 15° = 0.966; cosine 40° = 0.766; cosine 65° = 0.423.

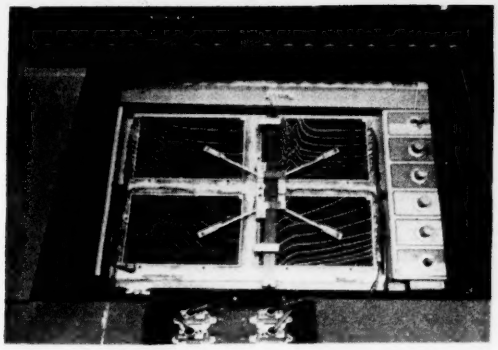


FIG. 1. PLOTTING TABLE with four pickups in place.

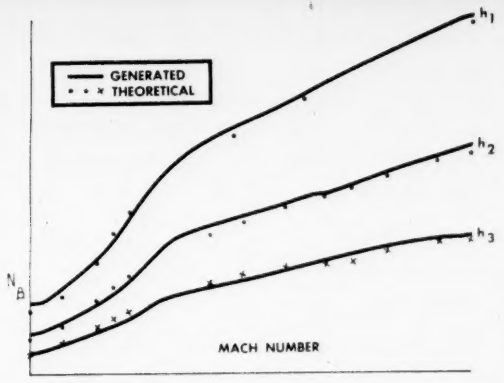


FIG. 2. COMPARISON of generated and theoretical values.

Multi-Variable Function Generator

Input to this function generator consists of three arbitrary variables. Output is the product of one of the three multiplied by an arbitrary function of the other two. Primary advantage is the ability to represent exactly complex functions of two variables and carry out a multiplication by a third variable.

THOMAS J. KELLEY
Convair (San Diego)

GENERATION of functions of two variables is one of the many problems involved in simulating a complex dynamic system such as an aircraft.

This special bi-variable function generator* generates any arbitrary single-valued function of two variables without recourse to straight-line approximations and requires only moderate setup and checkout time.

Function Generator

The device operates on the principle that an electric field can be set up in a semiconductive medium if a potential difference is maintained across the medium.

The semiconductive surface is coated on plastic and must (1) have a resistivity between 20,000 and 50,000 ohms per square inch, (2) be uniform, (3) be hard and smooth, and (4) be electrically stable so that its properties are not dependent on temperature and time.

If we are given any arbitrary function, $Z = f(x, y)$, we can determine the curves $y = g(x)$ for which Z is a constant. A number of these curves are found for various values of Z and these curves are painted in silver on the surface of the semiconductive medium (Fig. 1). A voltage representing the values of the function is impressed on each line by a voltage dividing network.

The voltage at any point on a line is equal to the value of the function for that particular x and y. A voltage gradient is maintained through the semiconducting medium between two lines of unequal voltage. Thus the surface acts as an interpolative device just as though an infinite number of lines of constant (Z) value were painted on it.

The accuracy of the interpolation depends on the shape of the lines and the space between them. Fig. 2 shows the actual and theoretical values of $Z = f(x, y_o)$ where Z is a stability derivative, x is Mach number, and the y_o's are various constant altitudes. The constant-Z lines in Fig. 2 are not the painted lines, but lines of constant voltage on the semiconductive surface between the painted lines.

A variable voltage u can be impressed on the voltage divider that supplies the Z voltages to the painted lines. The voltage ratio between each pair of lines will remain constant, so driving the divider with a variable voltage will allow a multiplication to be performed on the plate—i.e., the voltage at any point on the plate will now be uZ or $uf(x, y)$. This is one of the main advantages of this device because the terms of the equation of motion are of the form $uf(x, y)$. (Z is taken as a function of Mach number and altitude, and u is one of the airframe variables, such as pitch rate, angle of attack, roll acceleration.)

The voltage at any place on the plate can be read off by a pickup on the plate; the pickup is positioned by voltages corresponding to the variables x and y.

The function generator is capable of generating 40 arbitrary single-valued functions of two variables. It will accept up to 10 different pairs of variables. The plotting table upon which the conductive surfaces are placed is a modified Electronics Associates Model 1100D Variplotter. The table will accept either a 15″ x 17″ plate or four 5″ x 7″ plates. The arm will accept either one or four pickups, depending on the number of plates on the table (Fig. 1).

*Manufactured by Conductive Surface Company, Richland, Mich.

FIG. 1. THE variable scale.

THE VARIABLE SCALE

Scales are fundamental to all measurements—yet knowledge that a graduated scale can be a flexible mathematical tool is not generally appreciated.

JOSEPH GERBER
Gerber Scientific Instrument Co.

POWER OF A FLEXIBLE SCALE is apparent from the many many mathematical functions that can be performed on a "Variable Scale."* These functions include curve multiplicaton and division, reproduction to scale, normalizing, interpolation and cycle counting. Thousands of such basic calculations are performed manually and laboriously each day.

The Variable Scale

The Variable Scale is a coiled spring with one end fixed and the other attached to a movable rider with a hairline (Fig. 1). There are 100 calibrated coils on the spring, with color coding for easy identification and reading.

The hairline rides over three fixed engraved scales —(1) the I or *inch* scale, which tells the number of inches that the flexible scale is extended; (2) the R_I or *reciprocal* scale, which tells the number of coils per inch at any extension, and (3) a Log $_{10}$ or conventional *logarithm* scale, which tells the logarithm of the extension. Note that the I and L_{10} scales are the same as the L and C scales of a slide rule (with the first 1 inch missing).

Each scale, plus the spring, solves a group of common problems.

Problems Involving the Calibrated Spring

Graphical Multiplication and Division

Many curves must be replotted as a family or multiplied by a constant. As shown in Fig. 2, curve *a* is simply converted to curves representing 0.2*a*, 0.4*a*, 0.6*a*, or 0.8*a* by first extending the variable scale in the position shown, with 100 coils representing the

*Registered tradename Gerber Scientific Instrument Co.

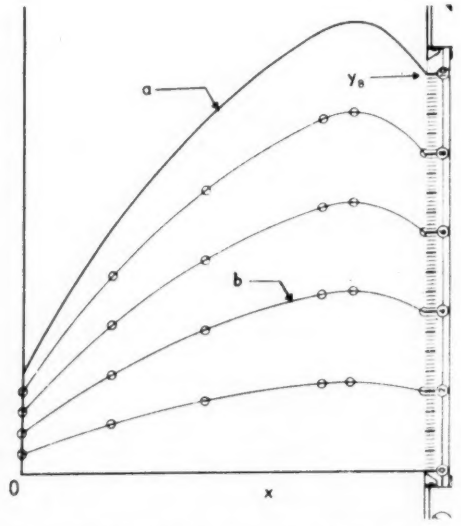


FIG. 2. REPLOTTING curves to different scales.

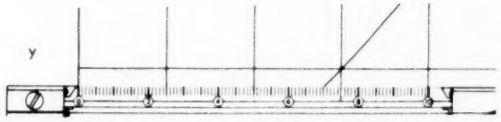


FIG. 3. READING A COARSE grid (or no grid). Setting 86.5 coil on x = 100 performs automatic multiplication of any reading by constant factor 865.

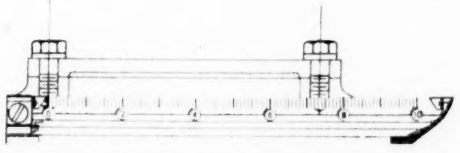


FIG. 4. OBTAINING DIMENSIONS from a scaled drawing.

height of curve *a*. Any proportion of *a* can be immediately seen from the rule. Note that no graph grid or calculation is necessary.

A simple extension of the same technique makes it possible to replot curve *b* so that the curve passes through any given point y_B. As shown in Fig. 2, this requires only that the scale be extended so that the 100-coil point is at the y_B point. It is seen that the *b* curve hits the 40.0 coil. At any other point, by placing the 40.0 coil on curve *b*, the 100-coil point marks the new curve.

Reading Graphs

As shown in Fig. 3, the scale can be used to read between grids on graph paper. Each reading can be multiplied by any factor, of say 0.865, simply by setting the 86.5 coil on point x = 100. Any reading will now be multiplied by the factor 865.

Obtaining Scale Factors

If only one dimension of a scaled drawing is known, the scale factor and any other dimension can be read directly from the rule. In Fig. 4, if the bolt diameter is known to be 0.500″, it is only necessary to extend the rule so that 5 coils extend across the bolt. Any other dimension then can be read directly. For example, the distance between the bolt center lines is directly read as 7.34″.

Normalizing

It is often necessary to compare any point on any curve to some normalized value (such as the maximum value). For example, in mass spectrometry peaks *a* and *b* (Fig. 5) must be read in terms of the maximum peak amplitude. This is done simply by setting 100 coils on the maximum amplitude and reading the other heights directly from the scale. Peak *a* is seen to be 0.613 and *b* is 0.418 of the peak amplitude.

If the heights in Fig. 5 were manometer heights, the ratio of pressures could be read directly.

This problem of dividing one length or amplitude into another is a common one. For example, in analysis of infrared recordings (Fig. 6) it often is necessary to determine the ratio $(I_1 - I_0)/(I_2 - I_0)$.

This is done simply by extending the rule so that 100 coils cover the distance $I_2 - I_0$. It is seen that the distance $I_1 - I_0$ is read directly as 0.252, the ratio sought.

Interpolation Between Curves

It often is necessary to interpolate between curves, such as finding the value of point P in Fig. 7. Place the instrument perpendicular to the line that bisects the angle of the two bounding curves, and extend the rule so that the 0 coil is at z = 1 and the 25 coil at z = 1.25. Note that 25 coils cover the interval between 1.00 and 1.25. It is seen that point P is z = 1.078 (coil 7.8).

Plotting Test Points

Test points are seldom nice even numbers. For example, given elevation or pressure points 713 and 719 in Fig. 8, it may be desired to plot contours representing 710, 715, and 720 units.

Since the difference between 713 and 719 is 6 feet, first set the 0 coil on point 713 and the 60 coil on point

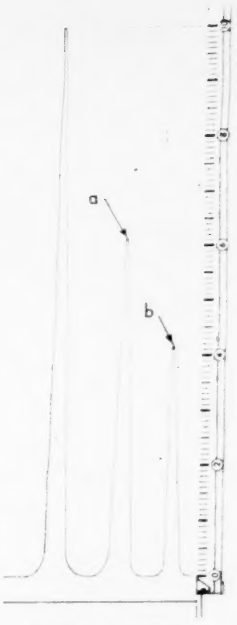


FIG. 5. NORMALIZING.

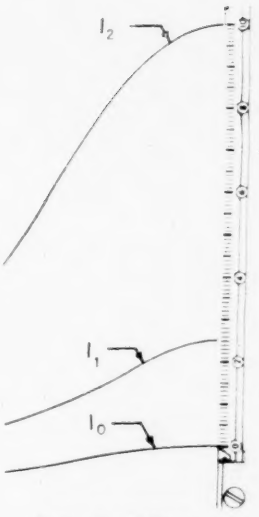


FIG. 6. DIVIDING one curve into another.

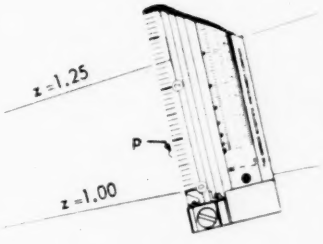


FIG. 7. LINEAR interpolation.

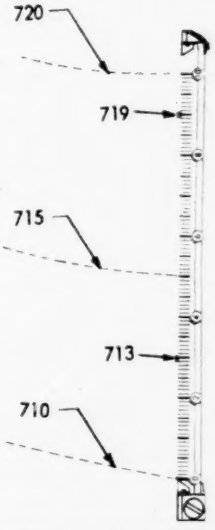


FIG. 8. PLOTTING test points.

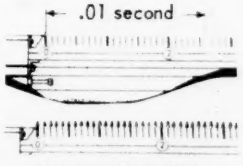


FIG. 9. COUNTING cycles.

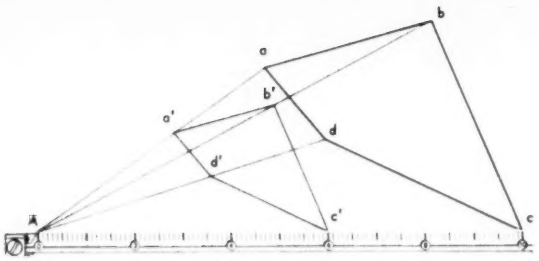


FIG. 10. PANTOGRAPH scaling.

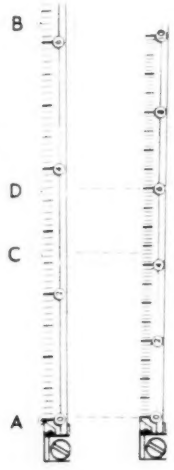


FIG. 11. TIME DISTANCE, and velocity problem.

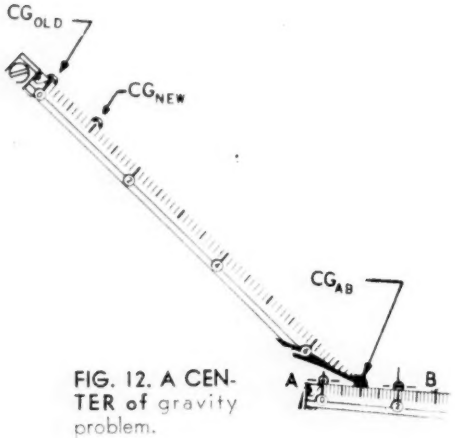


FIG. 12. A CENTER of gravity problem.

FIG. 13. READING a small distance with accuracy.

719. Now each coil represents 0.1 ft. The 710 point is now 30 coils below the 713 point: the 715 point is 20 coils above it; the 720 point must be 60 coils above.

Counting Cycles

Frequency is often found by a count of cycles—a tedious manual job. By extending the rule so that coil 1 falls on cycle 1, coil 2 on cycle 2, etc., as shown in Fig. 9, the number of counts between any two given points can be read directly. As there are 25.8 coils in 0.01 second the frequency is 2580 cps.

If the spacing between counts is not uniform, the slider can be adjusted to keep successive cycles in alignment; this averages the count.

Pantograph Scaling or Curve Reduction

The scale multiplies and divides distances rapidly. Fig. 10 shows how a figure abcd can be replotted so that its dimensions are 60% of the original. Locate the 0 coil at an arbitrary point A; locate the 100 coil at c. Plot point c' at the 60 coil. Repeating for points a, b, and d yields the new figure. Curves can be similarly reduced.

Time, Distance and Velocity Problems

Computations from maps and photographs can be made as follows: Suppose the distance between A and B in Fig. 11 is 63.2 miles. At a velocity of 35.6 mph, find the time to traverse distance AC, and mark off every 10 minutes of course.

With the 0 coil at A and the 63.2 coil at B, every coil represents 1 mile. AC is thus seen to be 26.3 miles. Point D (36.6 coil) represents one hour. Compress the coil so that 60 coils cover the distance AD. Every coil now represents 1 minute.

Center of Gravity Calculations

Adding rivets to strengthen a structure often requires tedious computation of the new center of gravity. Fig. 12 shows the simple solution with the variable scale when two rivets (A and B) are added to a 12-rivet system with a known center of gravity (CG_{OLD}).

The center of gravity of the new rivets is simply half way between them. This is found by extending 20 coils across A-B and marking the 10-coil point.

The old system has 12 rivets; the new has 14. The ratio of 12/14 is 60/70. Setting the rule as shown, with 70 coils between CG_{OLD} and CG_{AB}, locates the new C. G. at the 10 coil.

Scaling Small Lengths

If 10 coils are extended across a small dimension, as in Fig. 13, the reading at the rider (100 coils) on the I scale can be made to three figures. If the reading is 9.52, the dimension sought is 0.952 inch. Note that a reading within thousandths is possible.

Use of the Reciprocal Scale

Applying or Finding A Scale Factor

When reading oscillograms, it often is required to apply a scale factor to obtain the variable. For example, in Fig. 14, the scale factor is 1 inch equals 17,310 psi.

The R (reciprocal) scale reads coils/inch directly. Thus, by setting the rider on R 17.31 (17.31 coils/

inch), every coil represents 1000 psi. The reading shown is 89,400 psi.

Finding A Scale Factor

If the amplitude in Fig. 14 is known to be 89,400 psi and if 89.4 coils are extended across this distance, each coil represents 1000 psi. The R scale would now give the scale factor directly—17.31 or 17.310 psi/inch.

If one wished to lay off points at, say 1.21 points/inch, all that is required is to set the hairline at 12.11 on the R scale; every tenth coil will be spaced at 1.21 inch.

Engineering scales often must be made with odd rulings, such as 15.87 division/inch. Simply set the hairline at 15.87 on the R scale; every coil marks the desired division.

FIG. 14. APPLYING (or finding) a scale factor to a strain-gage oscillogram.

The Log Scale

Given any two logarithmic points, the rule can be used to interpolate or find any other point.

Note that the 0 coil represents 0 on the I scale, infinity on the R scale, and 1 on the log scale (that is, log 1).

Suppose the two points A and B in Fig. 15 represent points log 1 and log 5. Let us lay off a log scale based on these two points. Set the rider at 5 on the L scale. Set the 0 coil on A (log 1) and note that point B intercepts coil 59.2. To find the log 2 point, simply move the rider to 2 on the L scale; coil 59.2 will now indicate the log 2 point; for log 3, set the rider to log 3 on the L scale; again the 59.2 coil will mark log 3.

If two other log points are given, it is first necessary to locate the log 1 point before finding other points as described.

If points representing log 1 and 10 are known (as in Fig. 16), point A can be interpolated as follows: Set 0 coil on curve 1; set hairline to 10 on Log scale; note that point A is at coil 19.6. Compress the spring so that coil 19.6 intersects A. The reading on L scale shows this point to be 3.22.

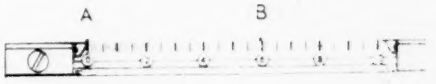


FIG. 15. MAKING a log scale to scale.

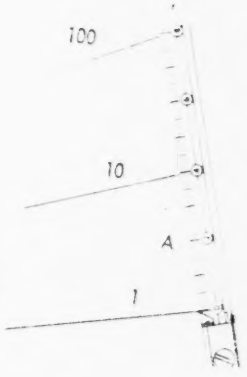


FIG. 16. INTERPOLATING logarithmically.

Power Ratios

The L scale permits the power ratio of two curves to be obtained immediately. If peak *a* in Fig. 17 is 3.78, find *b* as a power ratio of *a*—that is find *n* in $a^n = b$.

Set 37.8 coil over *a*, and note that amplitude of *b* is 26.9. This is the amplitude ratio we wish to express as a power ratio.

Set hairline at 3.78 on Log scale and note that coil 59.8 hits point *a*. Move hairline to 26.9 on Log scale and mark point b_L at coil 59.8. The ratio b_L/a is the desired power ratio. This is found simply by setting the 10 coil on *a*, reading b_L directly as 0.745.

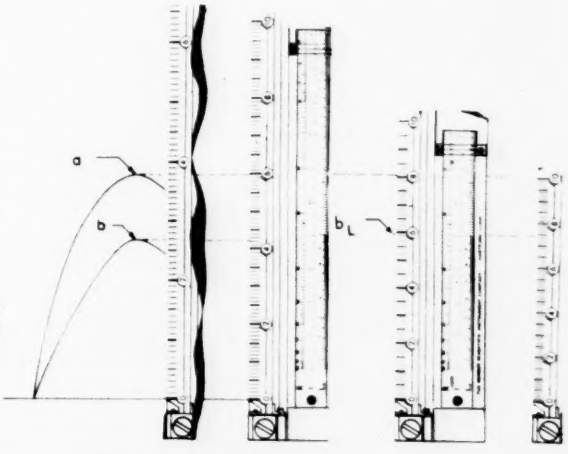


FIG. 17. POWER ratio reading.

The GraphAnalogue

The Variable Scale also is available with additional scales (on the area on which the slider rides) which can be used to (1) compare sine functions, (2) determine angles and rates of elevation, (3) plot a square (power) scale, (4) make probability estimates, (5) square, (6) cube, etc. This mathematical tool is called the "GraphAnalogue."

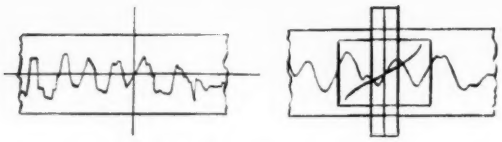


FIG. 1. MOST COMMON chart reading techniques involve use of cross-wires or templates.

CHART AND CURVE

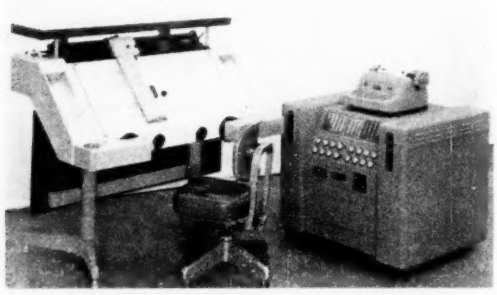


FIG. 2. TYPE 099 DataReducer.

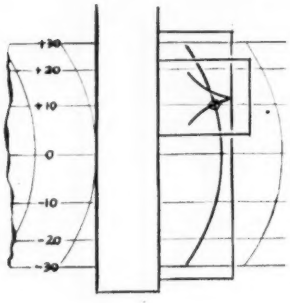


FIG. 3. CURVILINEAR template for one axis, and nonlinear template for applying correction in other axis.

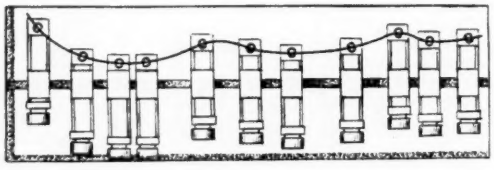


FIG. 4. FLEXIBLE STRIP can be bent into nonlinear shape to apply automatic nonlinear corrections.

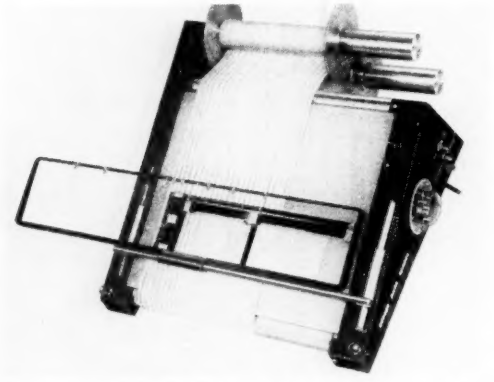


FIG. 5. GERBER DATA READER makes use of the Variable Scale.

Curve Readers

A FAMILY of mathematical aids is available for the common problem of rapidly and accurately reading data (coordinates) from curves. The two most common techniques involve use of cross-wires and templates (Fig. 1). The operator positions either the wires or template at the point to be read; data are given automatically in digital form with high accuracy.

Cross-wire readers are usually accurate, easy to use, and fast. Template readers can perform some operations impossible with cross-wire readers. However, they may be slow, less accurate, and harder to use. Each type is suited for a different kind of application.

Fig. 2 shows the Type 099 DataReducer*, a typical chart recorder. It can use both cross wires and templates, plus a target.

Templates attached to the arm and carriage carry the hairlines with are positioned over the point to be read. Fig. 3 shows how a curvilinear template is used with a curvilinear axis, and a nonlinear template with the other (vertical calibration) to apply corrections.

Orthogonal records also can have nonlinear corrections applied by techniques involving tilting the arms and special templates. Fig. 4 shows how a nonlinear correction can be applied automatically with a plug-in accessory called a "Linearizer." This consists of a flexible strip held in place by adjustable stops.

Some chart readers are designed to give digital readouts and printouts, and to work into punch-card and other data handling accessories.

The Gerber Data Reader (Fig. 5) is a variable-speed back-lighted oscillogram reader and scanner. Features include use of the coiled-spring variable scale (described elsewhere in this issue) to read amplitudes of any number of channels, including vernier technique for small amplitudes. The read head also can read frequencies, linearize nonlinear records, and correct each channel for reference line position and reference line drift.

Oscillogram readers are offered also by Coleman Engineering Co., Benson-Lehner Corporation, and others.

Curve Analyzer

A time-consuming and common problem is that of obtaining the equation of a curve or a set of points. In *Fourier Analysis*, the digital method requires that

*Registered tradename Telecomputing Corp.

Mathematical tools to aid in chart and curve analysis include chart readers, curve analyzers, equation finders, slope readers, micro-rules, rolling rules, and spacing dividers.

the curve be divided into a number of stations, preferably equally divided. At these stations the amplitudes have to be scaled precisely and then solved in a matrix. These computations usually are solved either manually or with large digital or analog computers. Even though the Fourier Series is very important in engineering problems, other equations are even more important. Equations such as *Power Series* or *Orthogonal Polynomials* (least squares) are also commonly solved on large computers whose cost is considerable and which require a staff of mathematicians. The Equameter* (Fig. 6) does this work much more simply. It gives the equation of a curve in a few minutes, directly from a graph or a series of plotted points. It is portable and requires no mathematical background.

The Equameter consists of back-lighted surface to which the curve to be analyzed is fastened. Carriages supporting the scales-hairline assembly and curves-coefficients assembly slide on a rail at the front of the instrument. A built-in Variable Scale is used to divide the curve under analysis into a number of equally spaced stations.

The curve to be analyzed is slid under the glass "curves" plate and hairline and is fastened to the instrument. The proper data sheet is selected for the analysis. These data sheets are presently available for Fourier Series to 13 terms, Power Series to the fifth power, and Least-Square Orthogonal Polynomials to 20 points. Other series can be programed as the need arises.

The Variable Scale is extended to the amount called for on the data sheet, thus automatically dividing the curve into the proper number of stations. At each of these stations one of the curves on the glass curves plate is made to intersect the point where the station-marking hairline crosses the specimen. At each station readings are taken from the scales, opposite the proper coefficients, and entered in the Data Sheet. The sum of each column on the Data Sheet yields one term on the series—with no memory, no programing, no electronics. For example, Fig. 7 shows a curve of density of water versus temperature. Using the Equameter, the form shown in Fig. 8 is filled in, which gives the equation for the curve directly:

$$\therefore \rho = 1\left\{1.1111\left[3.993+(-0.16)\left(\tfrac{2}{179}\right)(t-31.7)+(-0.497)\left(\tfrac{2}{179}\right)^2(t-31.7)^2\right]+58\right\}$$

$$\text{OR } \rho = 62.437+2.38\times10^{-3}t-6.892\times10^{-5}t^2$$

*Registered tradename Gerber Scientific Instrument Co.

FIG. 6. EQUAMETER can find equation for curve (in form of Fourier Series or least-squares orthogonal polynomials) in a few minutes.

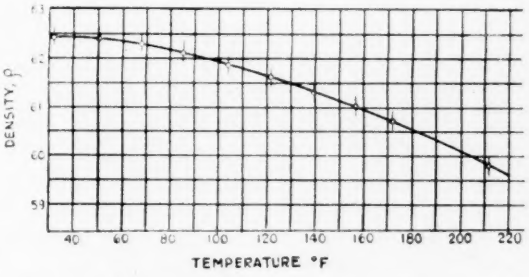


FIG. 7. CURVE OF DENSITY of water vs temperature.

SECOND POWER

Sta.	Coef.	a	b	c
0	0	L 4993	-L 4993	C 2498
		- 1000	-C 2498	
1	50		L 4336	-L 4336
			L 4336	
2	100		-C 1341	C 1341
	SUM	3993	- 0160	- 0497

FIG. 8. EQUAMETER data sheet for finding density equation.

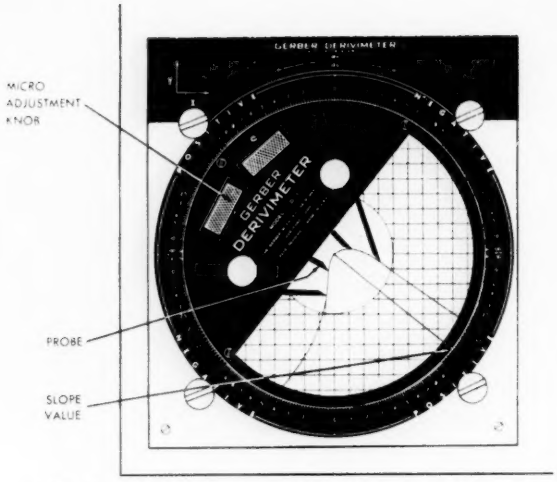


FIG. 9. DERIVIMETER reads both magnitude and sign of curve slope (dy/dx) at any point, directly.

FIG. 10. THE MICRO-RULE can read or plot to 0.001".

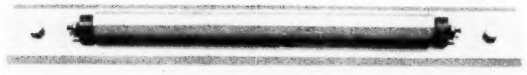


FIG. 11. THE ROLLING RULE maintains parallelism.

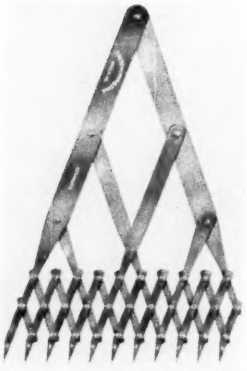


FIG. 12. SPACING DIVIDERS.

An 8-term Fourier analysis or a 3rd-power Power Series equation can be determined in about seven minutes. A 12-term Fourier analysis requires only ten minutes.

Derivimeter

The slope or derivative of a curve is required in many problems, including cam layouts, mechanical design, road planning, obtaining velocity and acceleration data from displacement curves, etc. The Derivimeter* (Fig. 9) is a simple device that will read the slope of a curve at any one point with an accuracy comparable to calculation from a known equation.

The principle is simple: if a pointer is *welded* perpendicular to a thin metal strip, and if the strip is bent, the pointer will always remain perpendicular at the point where it is fastened, irrespective of the shape of the bent metal strip. If we place this metal strip over a plotted or recorded curve with the junction point over the point at which we wish to read a tangent, and flex the strip to take the shape of the curve, the rod will then point in the direction of the normal to the tangent. As the end of the indicator registers on a circular scale, any deflection or rotation about the pivot pin is transmitted to the scale. The scale is divided into 4 quadrants to read the sign as well as the numerical value of the derivative. The deflection of the spring is controlled by the sliding of rods contacting the back of the spring.

By orienting the frame 90° counter-clockwise to the derivative position, the normal to the curve can be read.

Micro Rules

The "Micro-Rule"** (Fig. 10) is a scale with a vernier-calibrated extension that can read to 0.001". It can be used for measuring and laying out distances to 0.001" without magnification. Primary use is for accurate scaling and proportioning. Using a table of tangents it can lay off angles to minutes. It can set radii for circles, cams, etc.

Rolling Rules

The problem of maintaining parallelism while drawing and reading usually requires a drafting table. A simple solution is the rolling rule** (Fig. 11). This is simply a ruler mounted on a roller. The ruler can be rolled in the direction perpendicular to the roller, maintaining parallelism at all times.

Spacing Dividers

Spacing dividers** (Fig. 12) are linked mechanically so that they divide their variable total setting into ten equal parts. Up to 6" and 12" extreme openings are available. This can be used to divide and multiply chart distances, read small distances with accuracy, and lay off scale graduations.

*Gerber Scientific Instrument Co.

**Theodore Alteneder & Sons

FIG. 1. Texas Gas Transmission Installation at Owensboro, Kentucky uses a G-15D and CA-1, plus a Benson Lehner Oscar Model J (for digitizing graphical information using an IBM 024 key punch) plus a Flexowriter.

Who Uses Medium-Size Computers?

PHYLLIS HUGGINS, Bendix Computer Div., Bendix Aviation Corp.

WHERE are the medium-size computers today? A few years ago the relatively low-cost computers were introduced: today hundreds are installed, and orders are increasing. Where are they finding their place?

The Bendix G-15 general-purpose computer is an example. It is finding more rapid acceptance in some fields than in others for several reasons: One is that when computers begin to be used in a particular field, others profit from the experience of the pioneers and, where they see it is paying off, enter and add their own experience. Users tend to cooperate in idea sharing and program development.

Another reason is urgency of need. Some industries require arithmetic calculations to high accuracy.

Another reason is speed—as in missile tracking and impact predictions systems.

In many cases computers are solving problems in much the same way that they were previously solved with desk calculators, slide rule, or paper and pencil. In other cases they are utilizing mathematical procedures not previously possible.

The largest group of Bendix G-15 users is in the *civil engineering field.* Close to 200 programs are in the Civil Engineering Library. Applications in this field cover bridge design, structures, soil analysis, traffic studies, run-off in sewer problems, as well as highway design and earth moving.

Another major category is the use of a lower-cost computer as a *satellite machine to a larger computer* in industry and government. It may be found as part of the closed-shop central group, preparing data for the giant machines, scaling, checking out trial portions of major programs and running problems not justifying more expensive machine time. It is also used to train the operating staff and to introduce technical personnel to computers. Textile, chemical and petroleum labs that had only remote use of a central facility would previously develop only a few new programs a year. Now, with their individual machines, they average several new programs a week.

According to the head of a large petroleum research center, "If only one 'off beat' idea a year works out, the computer has amply justified itself. The man developing a new idea or design is not always even sure how to get out of the machine the answers he wants. You can't afford this type of work on big computers." The repetitive programs for these groups are data reduction and statistical. Considerable experimental money is saved the organizations by *mathematical simulation of chemical mixtures, distillation processes, refinery methods, oil well operation,* and by more completely evaluated *test data.*

In engineering groups the G-15 is used to check out new designs, eliminating vast sums formerly spent on test models. In the radar field a major program takes care of all the calculations required for new antenna designs; at an aircraft company it is used in landing gear design, at other companies it is used for the design of complex three dimensional cams and, with a digital differential analyser accessory, for airborne computer design, simulation and missile development.

A valuable contribution of the medium size machine is for *on-line use with test equipment.* Here it can take care of data evaluation and data reduction while the physical tests are in process.

A number of users are in the *nuclear reactor design field* where the computer has been found to be adequate for simulation studies.

A new area opening up is that of *real time control.*

Our technology and our science have become quantitative. The complexity found in every part of our lives is found also in the different levels of science, engineering, business and economy. The use of computers is thus essential in all fields today.

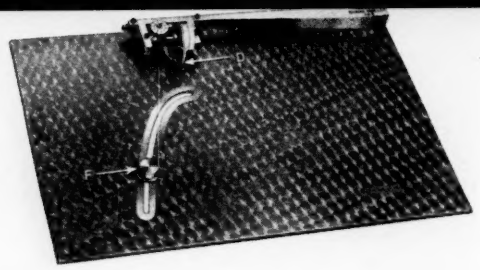


FIG. 1. TYPICAL circular-chart planimeter with tracer. (Courtesy The Foxboro Co.)

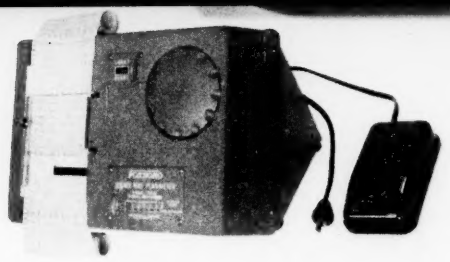


FIG. 2. PLANIMETER for strip chart. (Courtesy The Foxboro Co.)

INTEGRATION

THE INTEGRAL, or the area UNDER THE CURVE of a signal, is of importance in the measurement of energy, velocity, displacement, power, heat transfer, stress, and totalized quantities of flow and many other variables.

The basic ways for obtaining such integrals include (1) mechanical planimeters, (2) mechanical integrators, (3) electronic counting-type integrators, and (4) analog and operational techniques, as in analog computers. Typical examples of each type will be given in order to cover the many types available.

Planimeters

Fig. 1 shows a typical planimeter for integrating the area under the curve on a circular chart. Such planimeters are available for either uniform-scale charts or square-root charts. The chart is placed on the hub shown and the pointer (or pen) of the planimeter is made to follow the curve as the chart is rotated once. The difference between the readings on the planimeter dials (with vernier) before and after this operation gives the area under the curve (linear model) or the average of the squares (square root model). *Note*: the average of the square roots is *not* the square root of the average. Use of a pen on the planimeter tells how closely the operator follows the chart curve.

Fig. 2 shows a planimeter for a strip chart. Here again models are available for either linear or square-root charts. The foot switch shown moves the chart while the operator follows the curve with the tracer. A 30-day chart can be so integrated, with both the duration of the record and the integral indicated digitally on counters.

The Ball/Disk Mechanical Integrator

The ball and disc integrator is a precision (0.01% reproducibility) mechanical integrating mechanism which can perform a wide variety of mathematical functions. The growing list of applications include flow totalizing, computing areas under gas chromatography curves, averaging of any process variable, and applying correction factors to meter readings.

Fig. 4 shows the principle of the integrator. Rotation of the output shaft equals the $\int y\,dx$, where x is

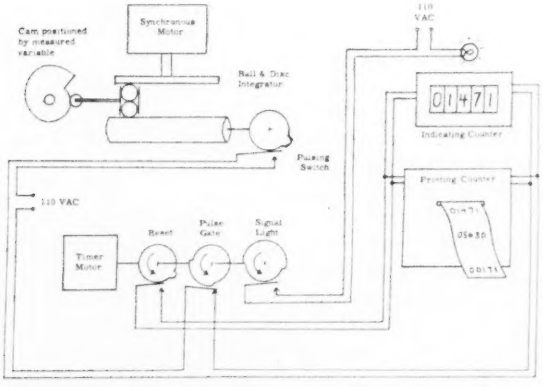


FIG. 3. INTEGRATOR plus timer and reset gates permits averaging. (Courtesy Royson Engineering Co.)

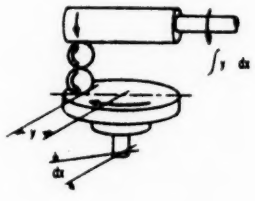
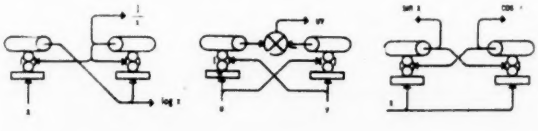


FIG. 4. BALL AND DISC integrator. (Courtesy Librascope, Inc.)

FIG. 5. GENERATING log x and 1/x (left), a product, and sine or cosine (right).



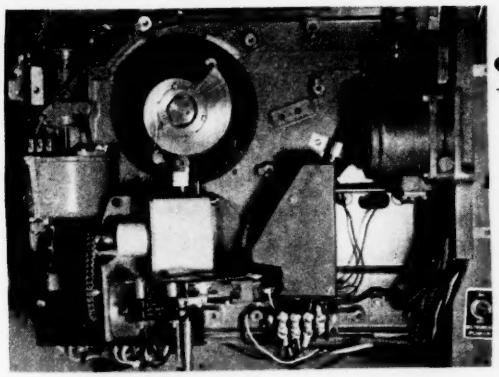


FIG. 6. INTEGRATOR on recorder chassis. (Courtesy Royson Engineering Co.)

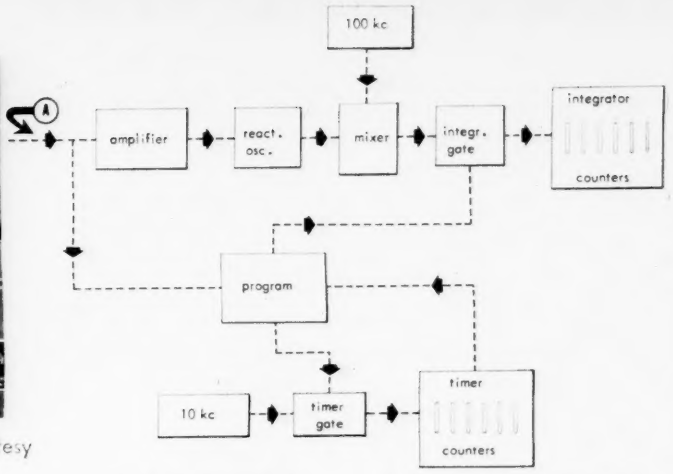


FIG. 7. BLOCK diagram of Alinco Model 270 integrator. (Courtesy Allegany Instrument Co.)

rotation of disc and y is displacement of ball from center of disc, *or vice versa*.

The output shaft can operate a switch to convert its rotation into a series of pulses (Fig. 3) which can be totalized for digital readout of the total integral.

Adding a timer (Fig. 3) permits the pulses to be counted for a given interval. This is, by definition *averaging*. An average value is valuable in many ways, including reading the value of some variable that is fluctuating rapidly.

Fig. 5 shows the ways in which the basic integral function is used to obtain other mathematical functions, such as log, inverse, multiplication and trigonometric functions.

In Fig. 5A it is seen that if x is one input, and if 1/x is the second input, then the output from the top left shaft must be log x because

$$\int (1/x)\, dx = \log x$$

If log x is fed to the input of the second integrator, and if 1/x is the second input, then 1/x is the output because

$$\int (1/x)\, d(\log x) = \int (1/x)(1/x)dx$$
$$= \int (1/x^2)\, dx = 1/x$$

The hookup shown in Fig. 5A satisfies both integration conditions.

Fig. 5B shows the hookup for multiplication. The output of the first integrator must be $\int udv$; that of the second must be $\int vdu$. Adding the two via a mechanical differential summer gives $\int udv + vdu$ which, by definition, is uv.

Fig. 5C shows the hookup for generating a sine or cosine function. The output of integrator 1 must be sin x if its two inputs are cos x and dx because $\int \cos x\, dx$ is sin x; similarly the output of integrator 2 must be cos x if its two inputs are sin x and dx. (All signs of terms have been ignored for simplicity).

Fig. 6 shows a typical integrator mounted on a recorder.

Electronic Counting Integrators

When signals in the order of milliseconds require investigation, a counting-type electronic integrator may be indicated.

Fig. 7 shows the block diagram of the Alinco Model 270 Integrating System. The operation is based on a reactance-tube oscillator. With no signal the oscillator is tuned to 100 kc, as is the fixed-frequency oscillator. A signal changes the frequency of the reactance oscillator, developing a beat signal whose frequency is proportional to the amplitude of the signal. The gates and timers permit integration (count of pulses) to start and stop at preset levels or preset times. This flexibility is shown in Fig. 8. The maximum count rate of 10,000 counts per second permits investigation of signals with durations as short as 10 milliseconds.

Fig. 9 shows the CR-2 time-function integrator of SIE. The input d-c signal (0-20 mv, 0-200 mv, or 0-2 v at 100 ohms input impedance) is amplified by two linear magnetic amplifiers and then fed to a linear magnetic integrator which produces a pulse rate proportional to the voltage input. The pulse output is zero to 20 cps. A lamp on the panel indicates the end of an integration cycle.

FIG. 8. INTEGRATION of portions of a signal.

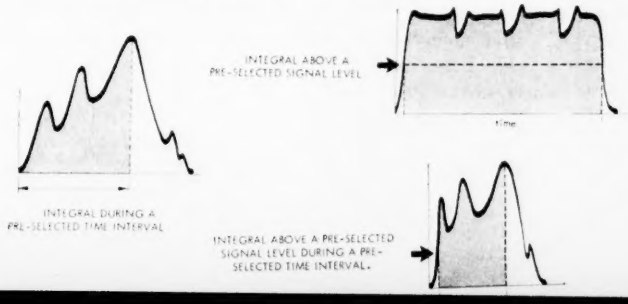

INTEGRAL ABOVE A PRE-SELECTED SIGNAL LEVEL
time
INTEGRAL DURING A PRE-SELECTED TIME INTERVAL
INTEGRAL ABOVE A PRE-SELECTED SIGNAL LEVEL DURING A PRE-SELECTED TIME INTERVAL.

FIG. 9. CR-2 time-function integrator. (Courtesy Southwestern Industrial Electronics).

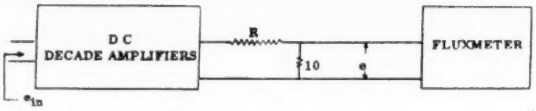


FIG. 10. ANALOG integrating system comprises d-c decade amplifier, voltage divider and Weston Inductronic fluxmeter.

FIG. 12. TIME-FUNCTION translator provides direct readout in desired units. (Courtesy Computer Measurements Corp.)

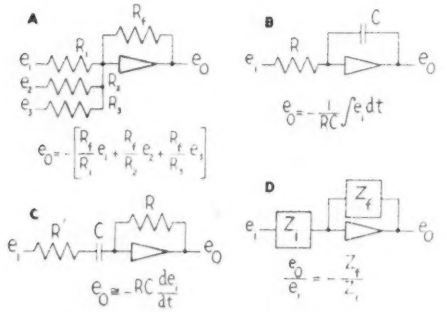


FIG. 11. OPERATIONAL AMPLIFIER is converted into summing amplifier, integrator, differentiator, etc., by feedback arrangements.

Analog Integration Via Fluxmeter

An integrator based on a fluxmeter has been reported in the literature*.

The integrating system comprises a d-c decade amplifier, a voltage divider, and a Model 1472 Weston Inductronic fluxmeter (Fig. 10).

The fluxmeter is the unit that performs the actual integration and exhibits a direct reading of $\int e dt$ (where e = voltage and t = time). The reading is accurate for time integrations up to 1 minute. The full-scale reading of the fluxmeter is 5 mv-sec. This method of integration follows sharply rising or falling pulses.

Response from dc through 25 kc is ± 1 db; from 25 kc to 100 kc ± 3 db, in step-controlled gains of 0, 20, 40 and 60 db.

The instrument allows linear amplification of relatively low-level (millivolt) signals without appreciable error because the signal-to-noise ratio is large; for a 1-mv pulse applied for a 4-sec period the signal-to-noise ratio was 50/1.

Analog Computer Integration

Integration is one of the four basic mathematical functions performed electronically in the analog computer. These four are (1) multiplication, (2) addition, (3) integration, and (4) differentiation.

The basic element in most electronic differential analyzers is the direct-coupled amplifier. With various feedback elements, the unit d-c amplifier becomes either a multiplier, a summing element, a differentiator, or an integrator.

Fig. 11 shows how resistors are used with the amplifier to produce a summing amplifier. A triangle is the conventional symbol for an operational amplifier;

e_i is the input voltage; e_o the output; R_i the input resistor; R_f the feedback resistor; gain of the amplifier is in the order of 30 million; amplifier draws no grid current.

The maximum output voltage is 100 volts. Therefore, the voltage at the summing point (point A where R_f and R_i meet) must always be less than a few microvolts. This can be considered zero for computing the current in the input resistor.

As point A is effectively at zero potential, the current in the input resistor (I_i) is E_i/R_i; similarly, current in the feedback resistor (I_f) is E_o/R_f. Assuming zero grid current to amplifier, the current in the input resistor must equal current in the feedback resistor, or $I_i = I_f$.

Thus, if R_i equals R_f, then $E_o = E_i$.

Point A is called the virtual ground because it never departs from zero potential by more than a few microvolts. It is important to understand this basic feedback circuit because it illustrates the principle by which various operations are performed with the operational amplifier.

This use of total feedback around such a high-gain amplifier is a dramatic illustration of the entire feedback concept, about which so much is written. When R_i and R_f in Fig. 11 are equal, point A, the virtual ground, does not depart from zero potential by 1 part in 1 million; yet the output is a perfect inverse of the input signal.

When a capacitor is used as the feedback path the summing point again remains at near-zero potential, yet the output becomes a near-perfect integral of the input signal.

Time-Function Translator

Many transducers, including turbine-type flow pickups and tachometers, sense variables in terms of pulses. The "Time Function Translator" (Fig. 12) is an instrument which counts and reads out the number of pulses developed. If the timing interval were one second, it follows that the pulse count could be multiplied by some combined factor K that included constants established by the flow pickup used and the type of liquid under test to produce the reading in the desired units—lb/min, gal/hr, etc. Similarly, varying the time base (the variable time interval) permits direct readout (pulse count) in the desired form. This is done simply by selecting a time interval such that the readout is in the desired units, without conversion tables, graphs, charts or calculations.

*Ralph Leibowitz, Analog Integrating of Transient Waveforms, *I&A*, October, 1957, pages 1881-83.

ELECTRONIC CIRCUITRY

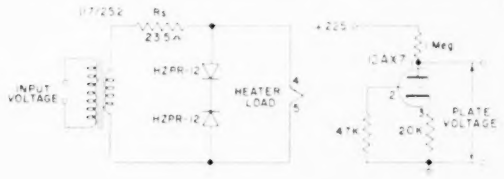
CHARLES F. KEZER
and
MILTON H. ARONSON

The circuit is the heart of all electronics. Here are 2 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

BACK-TO-BACK ZENER DIODES REGULATE A-C HEATER VOLTAGE

Two HZPR-12 power zener diodes are used to regulate the a-c heater voltage applied to a 12AX7 amplifier stage in this circuit. The two diodes are connected cathode-to-cathode, so that one operates on its reverse characteristic (in the "zener" region) while the other is conducting in the forward direction. On the next half cycle the operation reverses—that is, one diode regulates voltage during positive half-cycles, the other during negative half cycles.

The heater transformer used develops 25.2 v rms, which is equivalent to 35.5 v peak. When the instantaneous voltage across load and diodes is less than 12 v, the diodes have little effect. As supply transformer voltage continues toward the 35.5-v peak value, diode current increases and, owing to the voltage drop across series resistor R_s, the load voltage remains close to 12 v. The



load voltage is thus a heavily clipped sine wave; the fraction of a cycle during which the diodes conduct is higher at high line voltage than lower input voltage.

The rms value of the load voltage will vary with input voltage, even though the peak load voltage is held constant at 12 v. The improvement afforded by such zener diode regulation was measured by determining the change in the 12AX7 tube plate voltage produced by line voltage shift from 100 to 125 v rms. Plate voltage change was 7.5 v dc with unregulated heater; regulation reduced this to 1 v, an improvement of 7.5:1.

In the circuit shown, peak current supplied by the transformer is 1 ampere because resistor R_s drops the peak transformer voltage of 35.5 v by 23.5 v when diode current is a maximum. Hence the heater transformer must be capable of at least 700 ma rms, although heater current is only 125 ma.

The 12AX7 tube was connected for 12.6 v (150 ma) heater operation; a 6.3-v 300-ma heater, such as a 6SU7 tube, can be regulated by adding a 21-ohm resistor (or a similar heater of another tube) in series with the heater terminals, and by reducing the 23.5-ohm series resistor R_s to 19 ohms. The change in d-c plate voltage of a 6SU7 tube was reduced by a factor of 10 by such a regulating circuit, for line voltage change from 100 to 130 v.

Input: 100-130 v rms.

Output: Sine wave clipped to ±12 v peak; nominal load current, 150 ma rms.

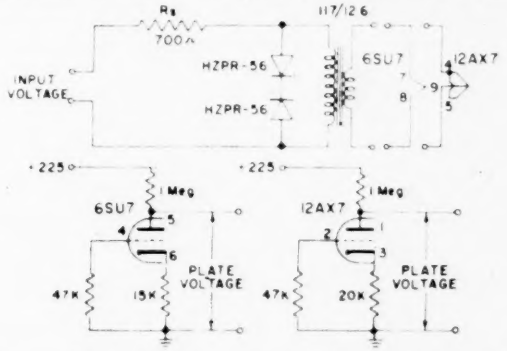
Improvement factor: 7.5:1, measured as described.

Source: Hoffman Electronics Corp., Semiconductor Division, 930 Pitner Ave., Evanston, Ill.

ZENER-DIODE A-C REGULATOR REGULATES TRANSFORMER PRIMARY

Operating on the same principle as the preceding circuit, this circuit uses higher voltage (56-v) power zener diodes in the primary side of the heater transformer. Circuit was tested with a 6SU7 tube heater (6.3 v, 300 ma) and with a 12AX7 (connected for 6.3-v operation).

A heater transformer rated at 117/12.6 v was used. As the diodes maintained the primary voltage at 56 v peak,



the secondary voltage was a nominal 6.3 v rms. As the primary current is smaller than the load current, the series resistor R_s must be much higher (700 ohms) than in the preceding circuit.

Effectiveness of the regulator diodes was checked by determining the change in plate voltage of the amplifier stage produced by a change in line voltage of 30 v rms. Plate voltage shift was reduced by a factor of 5:1 for the 6SU7 tube, and by 6:1 for the 12AX7 stage.

Input: 117 v rms.

Output: Nominal 6.3 v rms at 300 ma.

Improvement factor: 5:1 (6SU7) 6:1 (12AX7).

Source: Hoffman Electronics Corp., Semiconductor Division, 930 Pitner Ave., Evanston, Ill.

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MATHEMATICAL ELEMENTS FOR ANALOG COMPUTERS

MATHEMATICAL elements for analog computers include improved diode electronic multipliers, diode function generators, shunt and bridge limiters, and function relays.

The *diode electronic multiplier* makes use of the so-called quarter square principle:

$$(X + Y)^2 - (X - Y)^2 = 4XY$$

Diode multipliers using this principle with a simple parabolic function have long been known, but despite the obvious advantages of simplicity and virtually zero drift, little use has been made of them in real-time analog equipment. The reason was that the non-monotonic nature of the function created an ambiguity and required five amplifiers for a four-quadrant multiplier—an uneconomical operation. There was also difficulty when the variables were small, because of the uncertainties involved in using diodes at low voltages.

New diode electronic multipliers overcome these problems by use of two separate square-law functions*, each having an extra linear term added to it in such a fashion that both functions are tangent to a 45-degree line at the origin (Fig. 1).

Use of two monotonic functions eliminates any ambiguity and permits a four-quadrant multiplier with only three amplifiers (Fig. 2).

The circuit has a further advantage when the inputs go to zero. Since both square-law functions are tangent to a 45-degree line at the origin and are changing slope relatively slowly here, no diodes need be used to generate the function in this vicinity. The accuracy here, therefore, depends only on the precision resistors used. This means that this multiplier has its best accuracy in the vicinity of the origin, thus avoiding one of the major problems of electronic multipliers in general—namely, that elaborate precautions are required to take care of the fact that the product is not zero when $X = 0$ and $Y = 0$. This accuracy is maintained throughout the entire voltage range of ± 100 volts.

But probably the chief advantage of this multiplier is its extreme simplicity and reliability. There are no complicated circuits to drift or get out of order—just diodes. Further, all diode heaters are operated at reduced voltage, and the voltage is regulated to eliminate any possibility of drift from this source. Essentially, the only possible source of drift, therefore, is the aging of the tube itself; this possibility of drift is reduced by pre-aging of the diodes at the factory. The result is an electronic multiplier that is accurate and yet stable.

A new silicon junction-diode multiplier is currently available in which accuracy over existing multipliers is improved by a factor of 2½ while volume per channel is reduced by 75%.

*Patent of Reeves Instrument Corp.

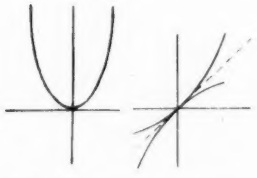


FIG. 1. New diode electronic multiplier uses two square-law functions.

Diode Function Generator

New designs of *diode function generators* have significant advantages over conventional types—advantages that offer greater convenience of operation and also greatly extend its actual capabilities. Also, the reliability, simplicity and flexibility of both set-up and use of the DFG make it most attractive compared to other methods of function generation.

Fig. 3 shows one DFG panel. Note both the "break-point" and "slope" controls are ten-turn potentiometers with direct reading ten-turn dials. These allow direct generation of much higher maximum slopes than would be practical with single-turn potentiometers and dials. Using ten-turn units in conjunction with special diode circuitry allows generation of slopes of up to 12. Thus, even functions with steep wave fronts can be generated directly without the necessity of paralleling diode segments.

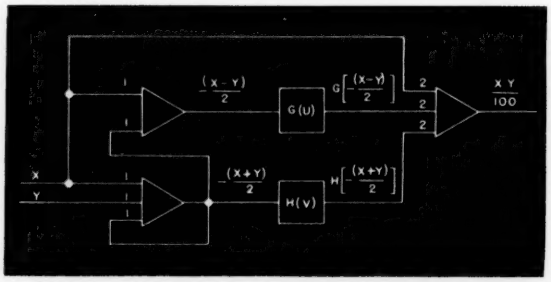


FIG. 2. Four-quadrant multiplier.

CHARLES LAX
PHILLIP I. RAFIELD

Reeves Instrument Corp.

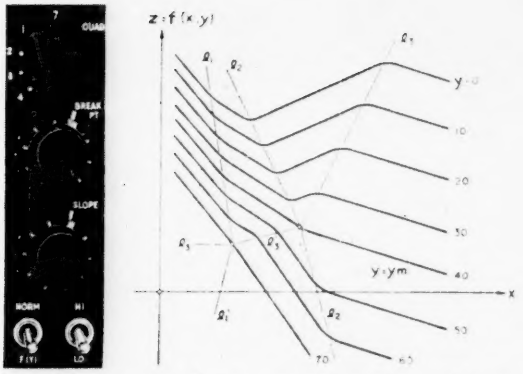


FIG. 3. DFG panel for one quadrant (left) and functions of several variables (right).

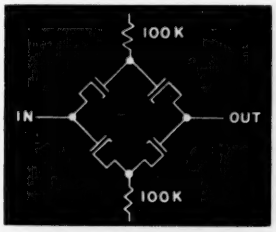
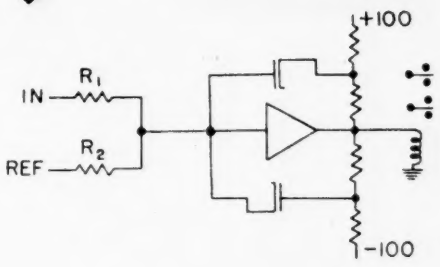


FIG. 4. Bridge limiter has sharp cut-off.

FIG. 5. Function relay.



Still a further improvement in resolution for smooth and easy setting of functions is obtained by splitting the slope control into two ranges, controlled by the switch at the lower right. In the "LO" position, the slope from zero to about one (45°) is spread across the entire ten-turn slope potentiometer, while in the "HI" position, the range of slopes from 1 (45°) to 12 (86°) is covered.

The use of ten-turn potentiometers and 1000-division dials for both break-point and slope offers another advantage—functions once set up can be logged and reproduced later simply by setting the dials to the same positions.

There are two other switches on the segment panel. The larger one at top selects the quadrant in which the straight-line segment appears. Each segment can be put into any one of the four quadrants, so that it is possible to begin function generation at any point in the function.

Functions of Two or More Variables

The other switch associated with each segment is tied in with a new development which is one of the most important features of this function generator. Throwing this switch from "normal" to "f(y)" switches the break-point return from the reference voltage to the patchbay, where it can be made a function of another variable (Fig. 3). It is thus possible to generate functions of two or more variables. The method of implementing this multi-function generation is described in detail in a technical paper by the inventor.*

Bridge Limiters

For maximum sharpness of cut-off, bridge limiters (Fig. 4) are available.

The behavior of these limiters beyond the nominal cutoff voltage is determined by the cut-off characteristics of the diode rather than by the forward conduction. The limiter characteristic is thus flat beyond cut-off rather than slightly sloping, as with simple diodes. This, then, is a better limiter for most purposes, and it is recommended for general-purpose use.

Function Relays

To be useful, relays used for switching during problem runs must have switching times negligible compared to the problem times. A new series of high-speed relays have been developed for use with the REAC® 400 Computer (Fig. 5). The voltage at which switching occurs is set by the reference voltage.

Any REAC 400 integrator or inverter can be converted to a high-gain amplifier for this switching service by patchbay switching. When amplifiers are so converted, their input resistors are freed and can be used as input and reference voltage resistors R_1 and R_2. Diode limiters are always required to prevent the d-c amplifiers from overloading, so these limiters are built in as part of the relay package. Two complete relay-diode units are supplied to a plug-in package.

Other new techniques for analog computation include automatic problem check, time-scale check, voltage scale check, patchbay vertifiers, and automatic computer operation from typed or tape commands. These have been reported.*

*Reeves Technical Article Reprint No. 101.

*Holton E. Harris, New Techniques for Analog Computation, *I&A*, May, 1957; also Reeves Technical Article Reprint No. 120.

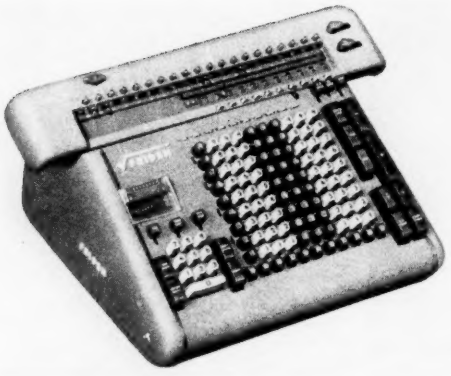


FIG. 1. FRIDEN MODEL SRW provides "touch-one-key" square root extraction in addition to fully automatic multiplication and division.

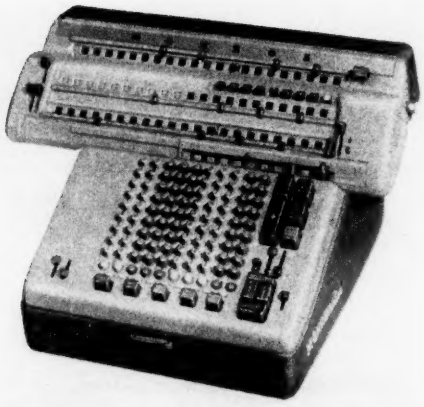


FIG. 2. MONROE MODEL 88N-213 has multi-factor multiplication feature.

DESK CALCULATORS

The mechanical desk calculator is a basic tool for statistical, engineering and mathematical work.

DESK-MODEL CALCULATING MACHINES generally are intended for use in the basic arithmetic functions of addition, subtraction, multiplication, and division, using rotary mechanical elements. Such machines can do the arithmetic in any mathematical problem which can be reduced to these fundamental arithmetic functions. Usually, when an engineering or commercial problem is stated in formula form, there is indicated a combination of several arithmetic functions, in any order. The requirements of the calculator are thus raised from that of a simple arithmetic machine to one which can handle the functions in a variety of ways, depending on the specific requirements of the work at hand.

This calls for flexibility in operation. From the introduction of the first automatic multiplying models, desk machines have eliminated the unnecessary operator decisions of preliminary dial clearance, carriage positioning and entry clearance at completion of the problem. As shown in the following equipments, "touch-one-key" operation requires the user only to enter the numbers and depress the operating control. All mechanical functions proceed automatically, the machine runs to completion of the problem, and stops with the answer readily visible at a predetermined decimal position. The time normally consumed in performing the necessary mechanical operations on less automatic machines can be utilized by the operator for recording answers or reading the next problem. This simplicity extends even to the problem of extracting square roots (see Friden Model SRW).

The "operating time" characteristics and constants of desk machines are not given in terms of "seconds or milliseconds" because each operation depends on mechanical actions that can proceed in different ways.

In statistical work, including quality control, the desk calculator is a basic tool, being taught to the students in that field. All engineers should be familiar with the ways that such machines are now being used.

Some desk-machine manufacturers supply tables and books for solving engineering problems with a desk calculator. For example, tables of natural trigonometric functions are used to obtain course and distance data, or to find the coordinates of unknown points.

In civil engineering, a partial list of problems suitable for desk-calculator solutions includes:

Addition and subtraction of angles
Interpolations of natural functions and logarithms
Computing course and distance
Area traverses
Calculation of coordinates

FIG. 3. NCR 38-M has printout feature.

Analytic geometry solutions
End area cuts and fills
Calculating grades, elevations and offsets

In mathematics, typical problems include:

Evaluating determinants
Computing accumulations in multiple correlations
Solving matrices
Partial correlation solutions
Partial regression coefficients

The price of such machines is in the $1000—$2000 range.

Friden Model SRW

The Friden Model SRW is shown in Fig. 1.

Many common problems involve the use of constant numbers. With two keyboards, the constant can be locked against accidental change. This advantage is further enhanced by the ability to handle the constant in different methods on the larger keyboard; many problems such as savings account interest calculations entail the use of a constant multiplier locked in the Multiplier unit, a constant divisor locked on part of the larger keyboard, and the rest of the latter left open for entry of variables. With such provision for positive retention of constants, the human element has no opportunity to raise the error incidence.

Automatic clearance can be prevented if it is desired to produce accumulated and individual answers simultaneously; direct production of positive or complementary quotients can be performed without special preliminary programming; division problems can be interrupted at the completion of any digit, and then resumed merely by re-depression of the division keys; entries can be entered, cleared, or adjusted without the necessity of working through the Keyboard; a tabulating button, set once, automatically and positively identifies the decimal point in all quotients without interfering with any of the other functions of the machine.

A special feature of the SRW is the Automatic Square Root Calculator that automatically extracts the square root of any number.

Monroe 88-N Duplex

The Monroe Duplex Model 88N has a special feature which makes possible multi-factor multiplication, with automatic decimal point. In other words, three or more numbers can be multiplied automatically. This multi-factor multiplication feature makes it especially suitable for engineering problems. Any number of factors can be multiplied together *without setting the intermediate products on the keyboard*, as is usually required with desk calculators. This also makes possible rapid raising of any number to any integral power.

An actual engineering problem that was rapidly solved on the 88-N even after it was programmed for a general-purpose digital computer involved the product of $A \times B \times \sqrt{C}$. The following few steps enabled it to be solved rapidly on a desk calculator.

$$A \times B \times \sqrt{C} = \sqrt{A^2 \times B^2 \times C}$$

A is entered on the keyboard and automatically squared by a touch of a key; so is B. The two factors are multiplied by a touch of a third key; C is entered and automatically multiplied by another key, with the three-factor product retained; the final function is the square root extraction, which is again rapidly done by entering a factor (from a chart) and operating one key. Results at each step of the problem are visible and retained, as is the final solution. Intermediate products and factor changes are thus possible. This is an important engineering factor.

Another important feature is simultaneous accumulation—after a multiplication or division, products or quotients automatically accumulate, with results appearing in another dial.

NCR 38-M

National Cash Register's Model 38-M (Fig. 3) accounting machine offers a new approach to combined multiplying and bookkeeping on such jobs as payroll calculating with wage accrual and billing and accounts receivable. It has a standard keyboard, electric typewriter, multiplier keyboard, and all other features that are present in the National Class 31 line. The difference is that the "38-M" is designed to handle jobs requiring rapid multiplication. The machine has these advantages:

1. It prints what it multiplies. For example, if a price is being multiplied by a quantity, it will print those two figures and also an extension of the result.

2. The decimal will be pointed off in the correct place.

3. The mills in the result will be rounded off automatically.

4. The machine can be set up to prove that factors have gone in correctly, in which case it is not necessary to rehandle the figures.

In handling payroll calculating jobs, it is not necessary for the machine to immediately multiply quantity of piecework produced times the rate for each employee. Instead, the operator continues to enter the quantities and rates for each rate group—before any multiplication takes place. In other words, all factors for all rate groups are entered before the machine even starts to multiply.

The DDA

ROBERT M. BECK

and

MAX PALEVSKY

Packard Bell Computer Corp.

FIG. 1

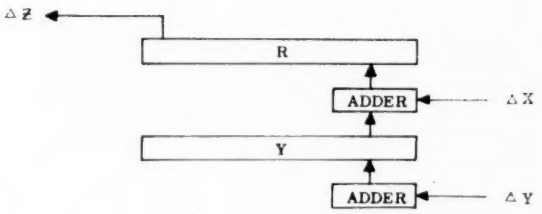


FIG. 2

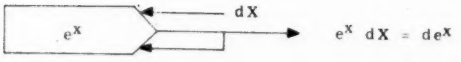


FIG. 3

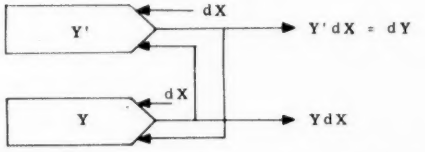


FIG. 4

THE Digital Differential Analyzer, or DDA, is a digital computer that simulates and solves differential equations by using analog techniques, including patching of the equation.

Theory of Operation

The basic element of an incremental computer, an *integrator* (Fig. 1), is a device that receives two incremental inputs, ΔX and ΔY, and generates an incremental output that is an approximation to YdX. If these increments are summed, the result is a number Z where

$$Z = \int YdX$$

over the interval of ΔX values that have been employed. Note that unlike electronic analog computers, the independent variable in this case can be any function and need not be time. This permits the generation of nonlinear as well linear functions by the same device.

The Integrator

The simplest mechanization of an integrator requires two registers and two adders (Fig. 2). ΔY is added to the first register to yield the successive values of Y. Upon the occurrence of a ΔX pulse, $Y\Delta X$ is added to R. The R value is thus $\Sigma Y\Delta X$, which is an approximation of $\int YdX$. Rather than accumulate this complete sum, however, the integral portion of the sum becomes a series of incremental outputs (ΔZ), which can serve as the ΔX or the ΔY input to other (or to the same) integrators. The action of the integrator has been clearly described in the literature.*

Two examples will indicate how integrators are interconnected. Fig. 3 shows the generation of e^x. If the value in the Y register, e^x, is integrated with respect to X, the result is $e^x dX$ or $d(e^x)$. But de^x represents the increments which, when summed, yield e^x. These increments are therefore used as the ΔY of the integrator itself, closing the loop. If, now, the Y value is started at some appropriate initial condition, the integrator will generate e^x.

A second example is the solution of $Y'' - Y = 0$. This may be rewritten as $dY' = YdX$. In Fig. 4, the first integrator holds Y′ and is integrated with respect to X, and so generates $Y'dX = dY$. The increments representing dY are summed in the second integrator and again integrated with respect to X. The result, YdX, is according to the given equation, equal to dY′. Therefore, employing the output of integrator 2 as the dY input to integrator 1 closes the loop and generates the required solution: sinh X and cosh X.

The TRICE Computer

The TRICE* computer is a DDA with a 100-kc iteration rate (number of integrations performed per second). It comprises a given number of integrators plus (1) a digital servo, (2) a variable multiplier to generate products of X and Y, (3) a ΔY summer that can receive up to six ΔY inputs and generate the sum, (4) a constant multiplier, and (5) a control unit, including 3-Mc clock generator and overflow detector.

Storage is provided by standard delay cable. Computing speed is independent of the size of the problem because all computing elements operate in parallel, like an analog computer. Physically one integrator is 9″ x 1¾″ x 20″ and uses about 85 transistors.

Sample Problem

Let us consider an example of Van der Pol's equation:

$$\ddot{x} + K(x^2 - 1)\dot{x} + x = 0$$

$$d\dot{x} = -K(x^2 - 1)\,d\dot{x} - x\,dt$$

*Klein, Morgan and Aronson, *Digital Techniques For Computation and Control*, Instruments Publishing Co., 1958.

*Registered tradename Packard Bell Computer Corp.

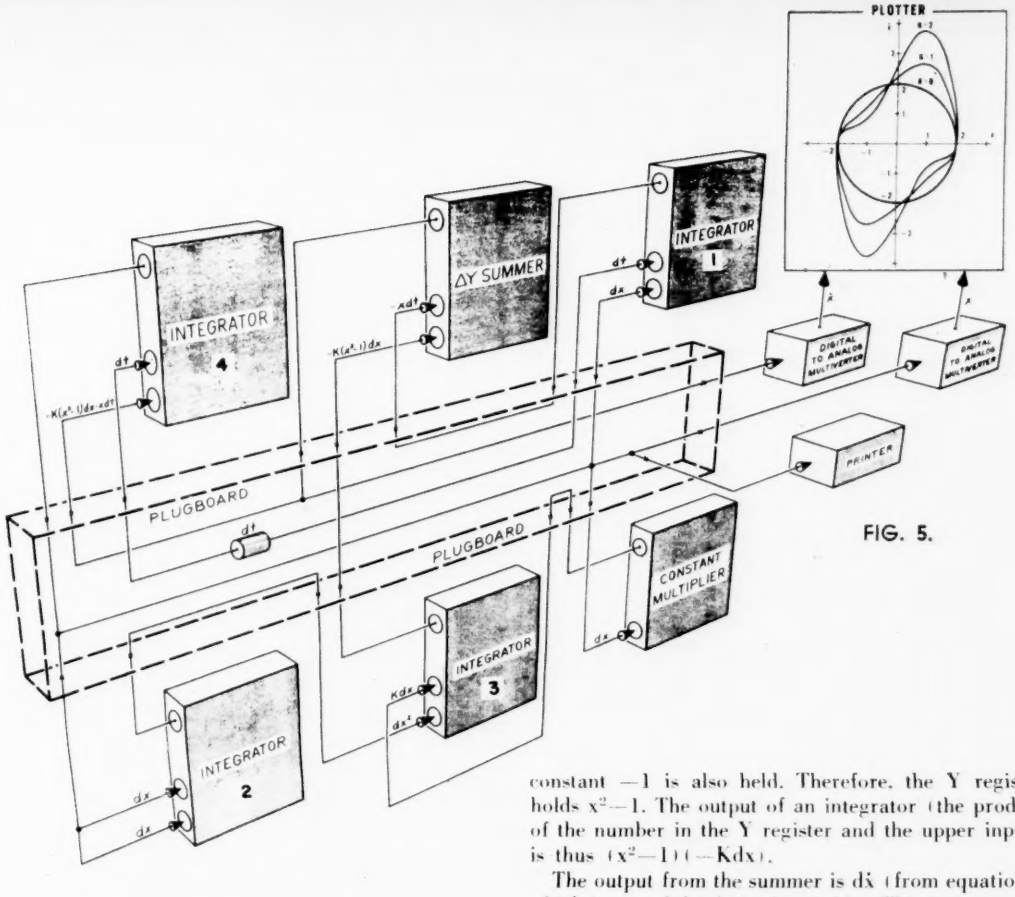


FIG. 5.

This equation represents a voltage loop in an oscillator circuit. The resistance term is K $(x^2 - 1)$. This term is positive when $x^2 < 1$ and is negative when $x^2 > 1$. The energy in the loop is increased when the resistance is negative and decreased when the resistance is positive. The equation has a stable oscillatory solution with the energy gains and losses cancelled for each value of K; in other words, each stable solution will be some form of a loop.

The block diagram (Fig. 5) shows the hardware required to solve this equation. The total number of components required are 4 integrators, 1 constant multiplier, and a ΔY summer.

Normally, the components would be interconnected by plugboard (symbolized by the heavy broken line). To show the exact flow of information in this diagram, the components have been connected by lines.

The basic variables are x and t. It is desired to plot x vs $\dot{x}$.

The two basic variables (x and t) are fed to integrator 1 at upper right in Fig. 5. The output is $-x\,dt$.

The dx input is also fed to the constant multiplier, which generates K dx for integrator 3.

Integrator 2 receives two dx inputs. The output therefore is xdx, which obviously is the same as $\frac{1}{2}d(x^2)$. The $\frac{1}{2}$ is taken care of by scaling so that the increments of output are effectively increments of dx^2.

The two inputs to Integrator 3 are $-Kdx$ and $d(x^2)$. The latter is added in the Y register where the constant -1 is also held. Therefore, the Y register holds x^2-1. The output of an integrator (the product of the number in the Y register and the upper input) is thus $(x^2-1)(-Kdx)$.

The output from the summer is $d\dot{x}$ (from equation), which is one of the desired variables. This is integrated against time in Integrator 4, whose output is $\dot{x}dt$. This is the same as dx, the second output.

Input into the computer for this problem could be made by any of the conventional means—typewriter, punched tape, etc. Output on this type of problem could be to two digital to analog "Multiverters" to an analog plotter. Normally, a series of solutions for various values of K would be plotted. When a satisfactory solution is reached, the digital values could be printed (via typewriter, line printer, punched tape, etc.). An actual plot of 3 stable solutions, (where K= 0, K = 1, K = 2) is shown on the plotter, which is plotting values of x and $\dot{x}$.

Applications

There are two broad areas of applications in which the DDA has been used:

The first category is as a design tool in the type of general computation and simulation normally conducted in computation centers. Typical problems would be in the fields of aerodynamic stability, control system stability, pilot plant simulation and missile trajectory studies.

The second area of application consists of using various elements of the computer combined into a special purpose computer for an operational system. Examples are: impact prediction, coordinate transformation for target acquisition, transformation of coordinate system for stabilizing devices such as radars, airborne guidance and control, etc.

ANOTHER NEW LESLIE PRODUCT

ADJUSTABLE PROPORTIONAL BAND Floatless LIQUID LEVEL CONTROL

...with adjustable level ranges up to 0-200"

Here is a new differential pressure-type liquid level control pilot that combines the wide adjustable level ranges in the table shown below with a 2-20" or 7-25" adjustable proportional band.

ADJUSTABLE LEVEL RANGE — INCHES	ADJUSTABLE PROPORTIONAL BAND (INCHES, H_2O)	CONTROL PILOT TYPE
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0-30 or 0-91	2-20	LABP
0-200	7-25	LAUP

Maximum Static Pressure — 300 psi

One Knob — Easy Adjustment

A single knob adjustment quickly sets the proportional band where you want it, even while the system is in operation. The liquid level is maintained constantly within that band until you re-set the control pilot for new conditions.

Applications

Leslie-Level-Matic Control Pilots are used in either open or pressurized vessels to control the level of virtually any liquid including water, gasoline, oil and chemical solutions. The new control pilot is particularly useful to maintain constant levels where there are high flow rates through vessels with small cross sectional areas.

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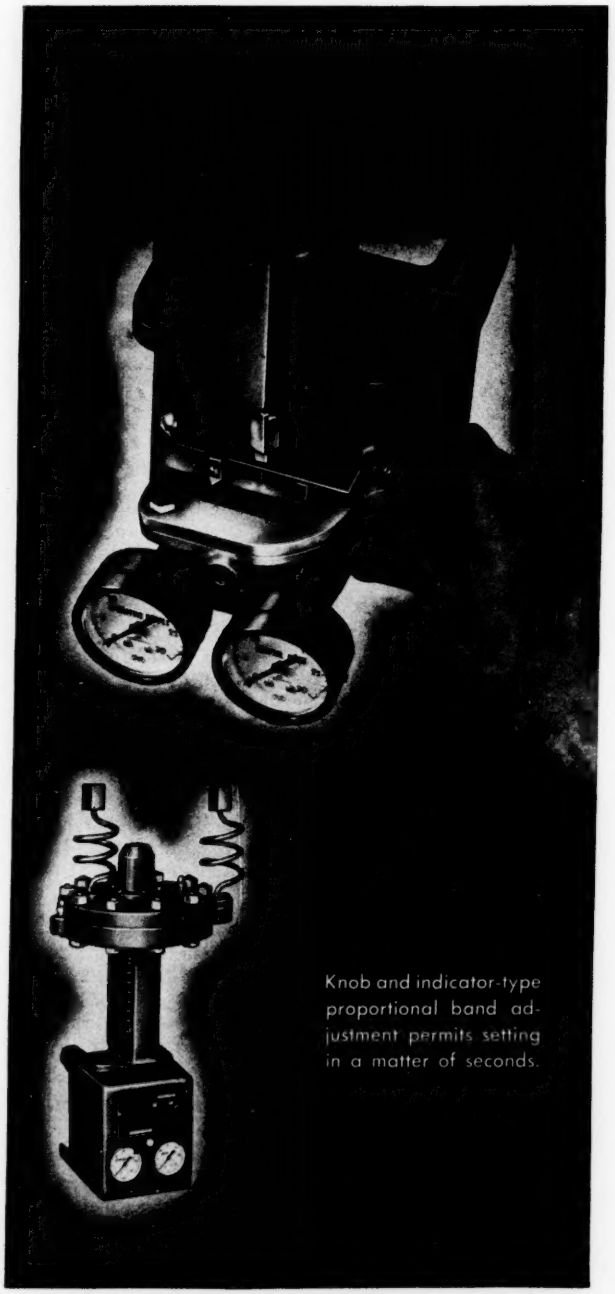
Send for Engineering Data Sheet describing this new Control Pilot and outlining its principle of operation.



Knob and indicator-type proportional band adjustment permits setting in a matter of seconds.

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Sizing of Safety-Relief Valves for Variable Back Pressure

F. D. MARTON
Instruments Publishing Company

C. G. WEBER
Farris Engineering Corporation

REGULATORS NO. 11

VARIABLE BACK PRESSURE in exhaust system poses special problems to relief valves. The blowdown system also must be considered.

The basic equations for sizing relief valves given in Chapter 10 apply only to constant back pressure. In this case conventional valves can be used regardless of critical or noncritical flow.

Flow conditions will be critical* in most cases because most safety valves exhaust to a low or atmospheric pressure. It is desirable that all flow through safety and relief valves be critical because the discharge velocity is greatest. However, where safety valves discharge compressible fluids into closed header systems, the back pressure can rise to the point where flow becomes noncritical, and a back pressure correction factor must be applied (see Chapter 10). This correction factor should be used in the formula when the critical pressure ratio exceeds about 0.53 for gases and vapors, 0.58 for saturated steam, and 0.55 for moderately superheated steam. Curves for back-pressure correction factors for vapors and gases (K_v) and for liquids (K_w) are available for specific valves.

When valves are set at very low pressures, atmospheric back pressure (14.7 psia) results in loss of critical flow conditions. This occurs when set pressure is 10.7 psig saturated steam, and 9.5 psig for vapors and gases with a $k = 1.001$ (where $k = C_p/C_v$).

Balanced Design

Balanced valves have been designed to be actuated by inlet pressure alone. In the design, shown in Fig. 11-1, the pressure in the outlet acts only on the bellows seal which, owing to its convolutions, has as much area "up" as "down." Hence the output pressure exerts no force in the vertical direction, and the valve is insensitive to back pressure.

*Critical flow occurs when the back pressure (or the downstream pressure below a short nozzle or any orifice of well-rounded approach) is less than about ½ of the inlet pressure. In this region flow is independent of downstream pressure and depends only on the upstream pressure. When flow is *not* critical, the flow depends on the pressure differential.

The Blowdown System

Closed blowdown systems are considered as variable-back-pressure installations.

Variable back pressure can be of two different types — (1) "built-up" back pressure, which is the system pressure created by flow from a given safety valve and the friction loss in its discharge, and (2) "superimposed" back pressure. The latter is encountered by a relief valve called upon to open in a manifold discharge piping system in which a back pressure exists either due to pressure purposely held in the system or owing to prior opening of other relief valves. In systems where these back pressures can reach values of 10% of the set pressure, chattering of conventional valves can result.

A relieving system may consist of from one to any number of relief valves manifolded into one common header for the prime purpose of safely disposing of vapors from overpressured equipment to a remote area of the plant site.

To adequately size the common header and the laterals from the relief valves, the designer must consider the following factors:

1. The ASME Unfired Pressure Vessel Code and other local, industry or regulatory codes.

2. Safety-relief valve characteristics and capacities. (The size of the valve depends on the pressure-differential across the valve with the percent accumulation available, as discussed previously.)

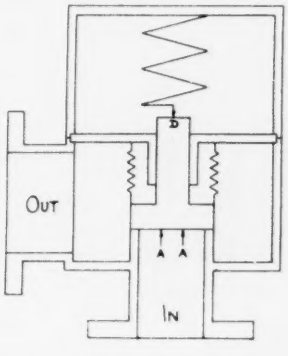

FIG. 11-1. BALANCED valve design.

3. Design pressure of the operating equipment associated with safety-relief valves.

4. Line capacities and line lengths.

5. Physical properties of the vapor to be relieved.

One method used to increase the permitted back pressure, when standard valves are used, is to lower the setting of a valve below the vessel design pressure. For example: Assume the design pressure of a vessel is 50 psig and the normal operating pressure is in the range of 5 psig. The relief valve may be set to open at, say, 30 psig, but is designed for full rated capacity at 55 psig (50 plus 10% of 50). This arrangement will now tolerate a backpressure, due to pressure drop, of 20 psig as against 5 psig based on the valve set at 50 psig with 10% accumulation. Consequently, the relief header may be designed for a smaller diameter pipe and use the same size valve as the one set for the 50-psig setting. However, chattering may occur under the given conditions.

The maximum carrying capacity of any line is limited by the acoustic velocity at the outlet of the pipe and in turn establishes the outlet pressure. Equations have been developed by Crocker* for solving the maximum pipe capacity of flowing vapors and gases.

A procedure for sizing vapor relieving systems is presented in API Report RP-520, dated 1955. A method developed by Joseph Conison of the Ralph M. Parsons Company has been accepted by the API as an alternate method to that in RP-520, and has the advantage of requiring only one calculation (as compared to the API method, which is based on trial and error).

*Piping Handbook, Sabin Crocker, 1945

B-58 VERTICAL VELOCITY INSTRUMENTATION

JACK WITHERS and W. R. JOHNSON

Convair Division
General Dynamics Corp.

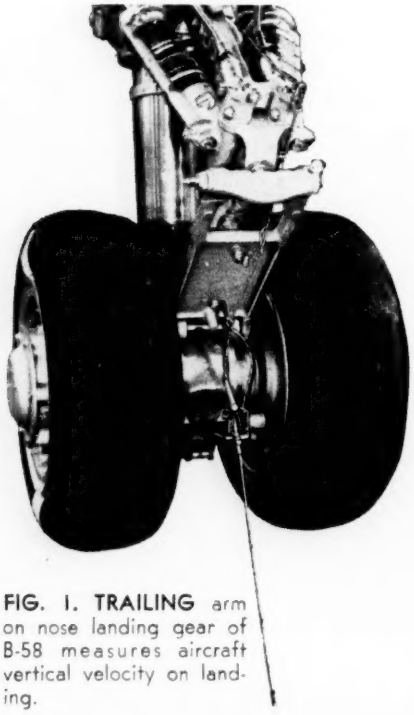

FIG. 1. TRAILING arm on nose landing gear of B-58 measures aircraft vertical velocity on landing.

AIRCRAFT LANDING-GEAR loads are affected by vertical velocity, aircraft weight and horizontal velocity. Aircraft weight and horizontal velocity measurements are relatively simple to obtain. Measuring vertical velocity at impact, however, presents design problems.

Initially, a system resembling that described in National Advisory Committee for Aeronautics TN 29061 was designed and built. This system consisted of a pivoted trailing arm with a small rubber-tired wheel mounted at its end. As the airplane settled to the runway, the trailing arm would move through an arc, operating a small potentiometer or Autosyn at its pivot point which would transmit the motion of the trailing arm to a recorder.

It was discovered during calibration that at expected magnitudes of vertical velocities the solid rubber-tired wheels developed a bounce; it was calculated that during landings of high vertical velocity the trailing arm would not return to the ground before landing gear contact.

It was decided to reduce the mass of the trailing arm as much as possible while meeting the requirement that there be no appreciable deflection in its length on contact. A workable compromise is shown in Fig. 1. The miniature truss is constructed of 0.090-gage spring-steel rod. The wheel is eliminated and the truss contacts and drags on landing.

A miniature null Autosyn attached to the trailing-arm pivot shaft transmits angular motion to a Sanborn recorder which gives a plot of trailing arm position versus time. The vertical velocity component at any time is calculated by comparison of the test tape with calibration record tapes. Vertical velocities to 8.8 ft/sec have been measured.

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CAPACITANCE AS A MEANS OF MEASUREMENT AND CONTROL

C. J. O'LONE
Robertshaw-Fulton Controls Company
The Instrument Division

CAPACITANCE is proportional to the area (A) of conductive surface acting as the capacitor plates, the dielectric constant (K) of the material between, and the inverse of the distance (D) between the plates ($C = AK/D$). Vary any of these three factors and capacitance is varied. This is the principle by which variable-capacitance measurements are made for indication and control.

Variable Area or Distance

Sensing mechanical position by capacitance change usually relies on a change in area or in distance between two objects.

When the motion of an object can cause a metallic surface to overlap another to varying degree, the position of the object changes the area of the opposing surfaces and thus their capacitance. When the movement is used to vary the distance between metal plates, then the varying distance between these plates will affect capacitance. These techniques have been used to detect mechanical travel, changes in minute distances, and frequency and amplitude of vibrations. However, area and distance variances have not found as wide application as variable *dielectric* in variable capacitance measurements.

Varying Dielectric Constant

Dielectric constant can be changed by changing the material between the plates or, for most materials, the moisture content of the material.

Moisture content to 0.1% of granular materials can be determined successfully by capacitance measurement. As moisture increases, the dielectric constant increases because water has a much higher K than that for the granular material. Drying operations can be controlled in this manner.

Change of dielectric constant occurs in level measurement too (Fig. 1). When level rises the material is being substituted for the air or gas that is present when the tank is empty. Interface level measurement can be accomplished in the same way—where the two materials have a different dielectric constant. Almost always, heavier materials have a higher K (except

Presented at October 17, 1957 SCMA meeting at Downey, California, while Mr. O'Lone was with Robertshaw-Fulton Controls Co.

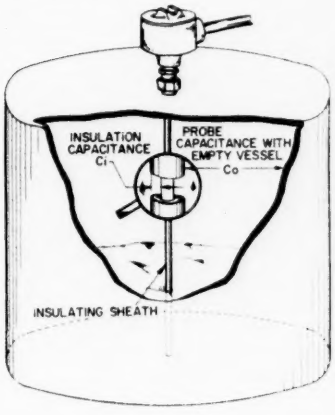


FIG. 1. PROBE WITH insulating sheath in tank.

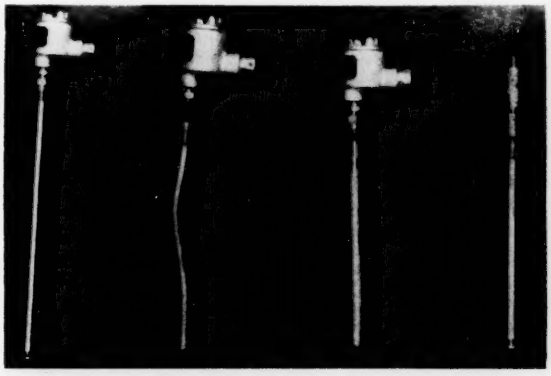


FIG. 2. TYPICAL ELECTRODE probes, including rigid, flexible, and insulated types.

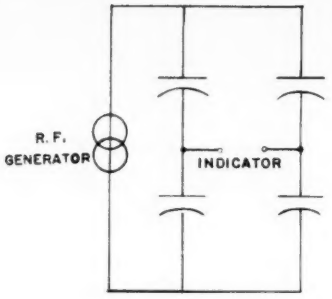


FIG. 3. BASIC capacitance bridge.

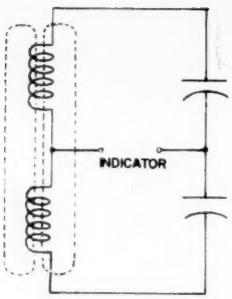


FIG. 4. MODIFIED BRIDGE with tuned oscillator.

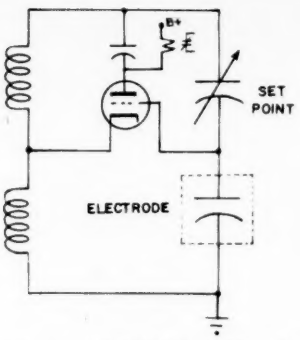


FIG. 5. VACUUM TUBE acts as capacitance relay.

for some few heavy hydrocarbons that are heavier than water but have a lower dielectric constant). Change of dielectric constant also occurs at the cut point when different materials are pumped thru a pipe line.

The Capacitance Transducer

The capacitance transducer or electrode (Fig. 2) is usually a rod or wire with an insulated mounting arrangement. A compression gland allows the rod or wire to be insulated and yet be sealed against leaks at positive or negative pressures. Stainless steel is almost always employed for the rod because of its corrosion resistance, although aluminum, Hastelloy and all types of metals (even Haveg) have been used. Teflon's corrosion resistance, imperviousness to most chemicals and resistance to deposit formation make it the front runner among the insulating materials. Kel-F is excellent for low-temperature applications.

Electrodes can be rigid, flexible, sheathed or ruggedized. They can be made for high temperatures to 2500°F. for high pressures to 25,000 psig. and in varying lengths from 2" to 150' or longer. Long flexible electrodes can be dangled into tanks and simply weighted or fixed at both ends.

The concentrically sheathed electrode requires that the material to be measured must get into the space between the outer grounded sheath and the center electrode. More often the electrode is a single rod and the tank becomes the other plate. Normally, the change of capacitance per unit length along the electrode is the same so the electrode develops a linear change of capacitance with level. The position of the electrode in the tank or pipe has only a slight effect on the operation of the electrode.

The electrode is placed so as to be clear of incoming material, agitators, etc. Electrodes can be positioned horizontally for fixed level control, vertically, or at some angle for continuous level measurement.

Electrode Sensitivity

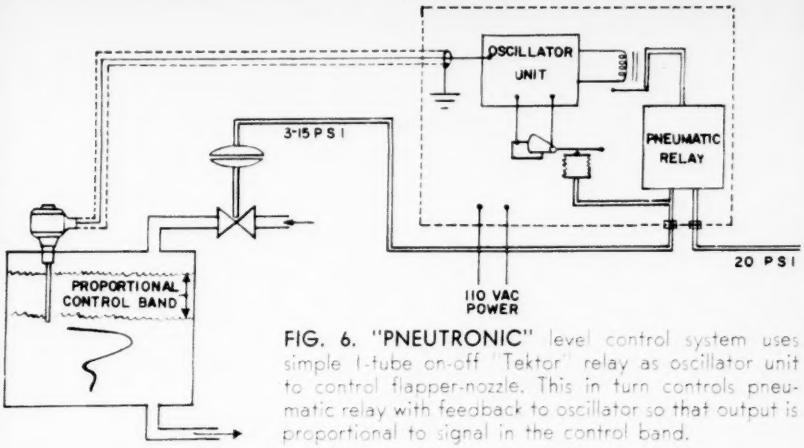
An important consideration in electrodes is the measuring sensitivity—how much capacitance change is caused by a change of say, one foot of level of material at any given dielectric constant. A larger center rod or a thinner wall insulation increase the capacitance change per foot of level. Different insulating materials on the rod or wire cause different sensitivities. Sensitivity of a given electrode varies too, depending on the diameter of the vessel in which it is installed. Generally, if the vessel exceeds 14" diameter, the sensitivity is the same as in a 14" diameter pipe. A good round number for sensitivity, generally used on a standard Teflon-covered rod or flexible electrode, is 35 $\mu\mu$f/ft. In an aqueous solution a standard 6" electrode for on-off control provides a change of 15 $\mu\mu$f or more in water. In low-dielectric material this may be only 2 or 3 $\mu\mu$f.

Electrical energy levels in the electrode are 200 to 500 times below the minimum ignition energy level for methane gas. The electrode is intrinsically safe when used with capacitance bridge equipments.

Capacitance Bridges

Almost all types of dependable, accurate, capacitance-sensitive instruments employ a capacitance bridge circuit. The basic bridge comprises four capacitances in two pairs connected across an a-c voltage source (Fig. 3). The voltage source should be alternating and have a high frequency—100 kc and upward. Frequencies near the 500-kc range are used for short rods; 100 kc for long rods. For small capacitance changes such as occur in moisture measurement, frequencies up to 27 Mc can be used. Power-line frequencies of 60 and 400 cps have been used. However, the measuring currents become so small that leakage currents often mask the true measurement. Insulators become impractical at these power-line frequencies as accumulated dust can provide a low-leakage path. This problem is overcome when using frequencies above 100 kc. The signal level of process-measuring capacitance bridges is so low that no measurable radiation results.

Capacitance bridge can comprise two pairs of capacitances, or one pair of capacitors and the other pair either resistors or inductors (Fig. 4). Such an LC circuit can be tuned to the measuring radio-frequency signal. The bridge balance is determined by the measuring electrode and the output signal is converted into a control signal either to operate an electronic relay (Fig. 5), or to control a motor circuit, or to indicate on a panel meter.



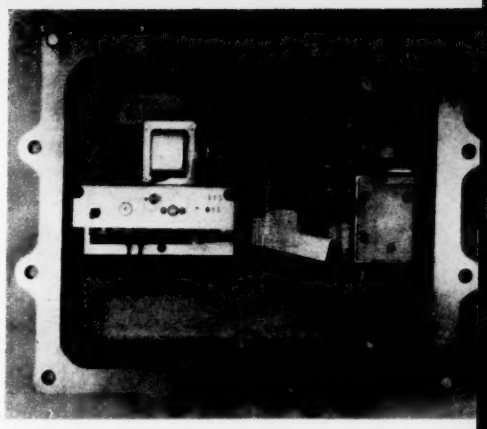


FIG. 6. "PNEUTRONIC" level control system uses simple 1-tube on-off "Tektor" relay as oscillator unit to control flapper-nozzle. This in turn controls pneumatic relay with feedback to oscillator so that output is proportional to signal in the control band.

Capacitance bridge instruments can provide the following services:

1. On-off relay alarm and control service
2. Continuous level indication on a panel meter
3. Continuous level recording and controlling

Control can be on-off electric, on-off pneumatic, narrow-band proportional pneumatic, or wide-band proportional pneumatic; it also can have reset and rate actions. A retransmitting slidewire is available for remote slave units. Fig. 6 shows a proportional pneumatic control system.

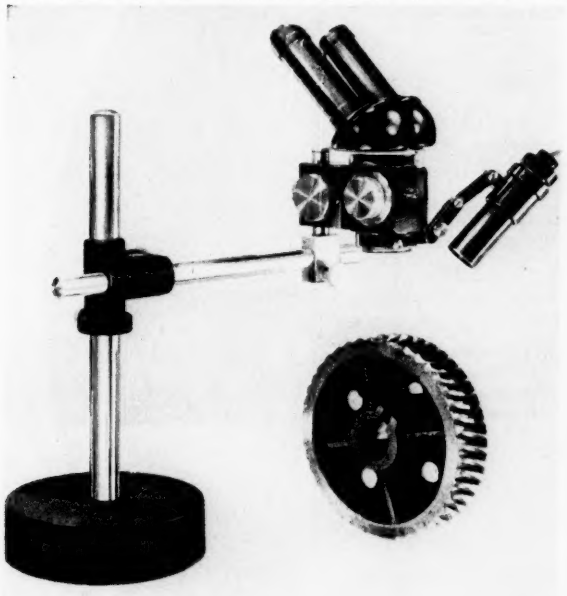
December Meeting: Thursday, December 18, Rio Hondo Country Club, Downey, Calif.
Feature: Past Presidents Night; Movie of Rams Football; L. C. Musselman, Yarnall Waring Co., will present a talk "Mexico Today."

Sensitivity

Sensitivities of approximately 1 $\mu\mu$f are standard, with stability such that the control point doesn't vary for months. When used with a 6" electrode providing a change much greater than the instrument sensitivity, variations due to drift are never evidenced.

Magnitudes of sensitivity vary from full-scale deflection caused by a change of 5 $\mu\mu$f, to full scale caused by a change of 2000 $\mu\mu$f. Practical measurements of level can be made from several inches for full scale to several hundred feet for full scale.

The transmitted signal has a magnitude of approximately one milliampere d-c full-scale with a bridge output of approximately 5 volts maximum. This value is sufficiently large so that stray fields have negligible effect and yet is small enough to be of no hazard.



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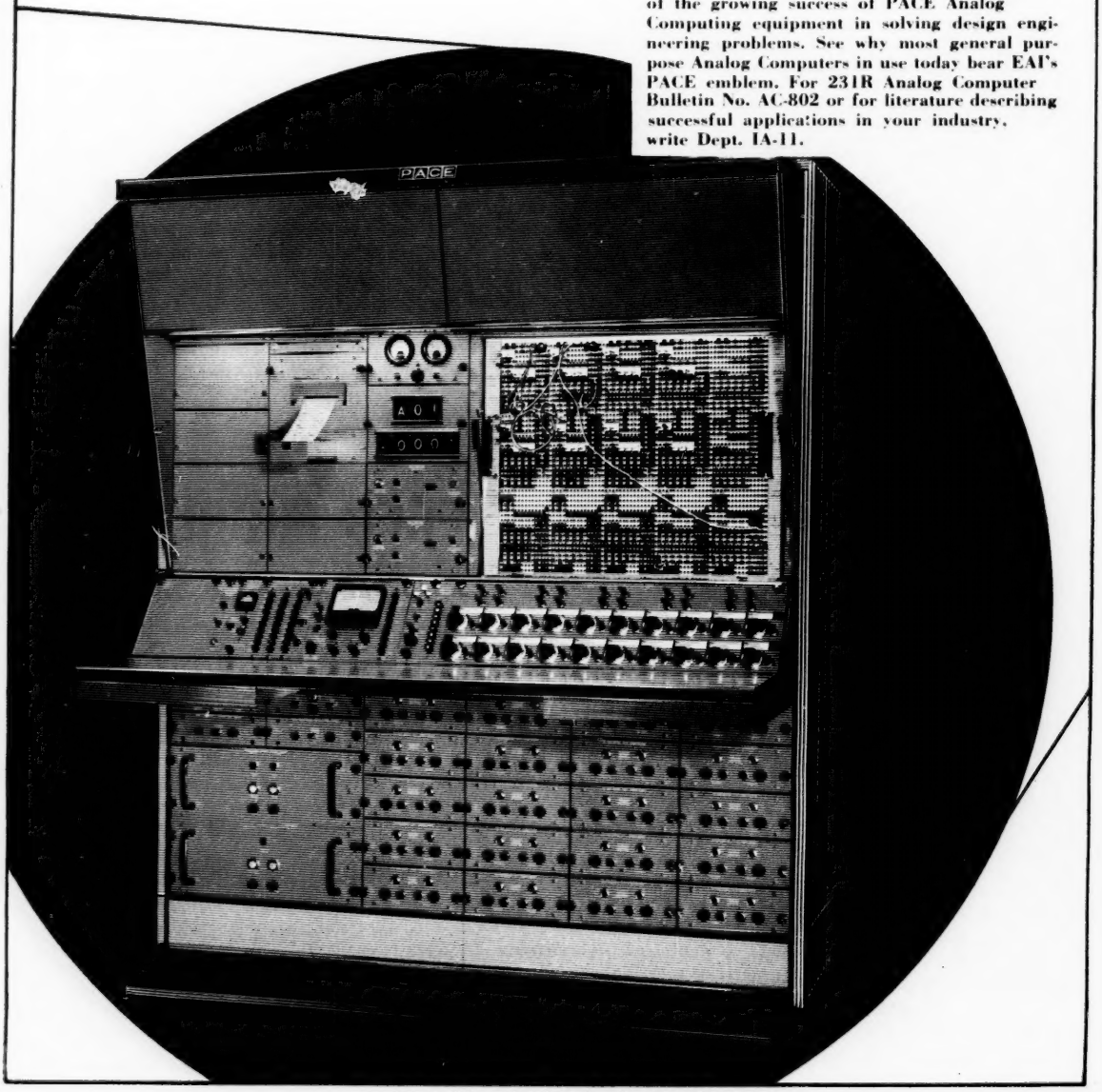

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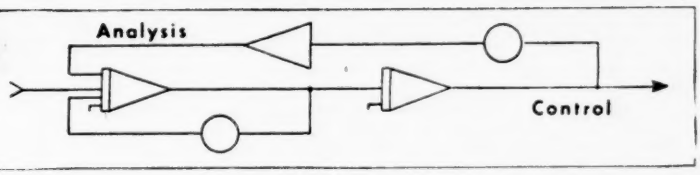

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Bits

This month we offer an account of the Western Simulation Council meeting of 11 September 1958, which was held at Convair-Astronautics in San Diego. Facts and figures (some of them rather astonishing) on Astro's computing facilities were presented by *Walter Schwidetzky* and *Walter Varner*. These were followed by an erudite discussion entitled "Is Your Computer a Pseudologist?" Among those who advised us how to catch the lying so-and-sos red-handed were *Bob Horwitz* (Equipment Maintenance), *Al Dinkle* (Patchboard Verifier), *Ken Tuttle* (FASE checking techniques), and *Milt Warshawsky* (the new WADC facility).

Pieces

WESTERN S/C MEETING OF 11 SEPTEMBER AT CONVAIR-ASTRONAUTICS

About 60 people accepted the Convair-Astronautics invitation to hold a meeting in the plush Astronautics Presentation Room in their new plant on the edge of San Diego, and to visit the new Computers and Simulation Laboratories.

Dr. Walter Schwidetzky, Chief of Computers and Simulation, welcomed the group and gave a brief description of the new Astronautics facility. Some of the facts:

There are some 1.13×10^{25} square Angstrom units of floor space located on a site about 1.5×10^{13} light years across. The plant took less than 20 millicenturies to build and cost about 4×10^{13} microbucks.*

*And the entire establishment is located in a gravitational field of approximately 7×10^{8} miles per hour a year.—Ed.

Walter Varner, head of the Flight Simulation Lab and Computers, who was host for the meeting, then gave us some more familiar-sounding facts about the Astro computation facility, which is one of the largest combined analog and digital computing labs in the Western World. (We don't know exactly what "the competition" has.)

The two laboratories combined have about 21,102 square feet of floor space. They are adjacent to each other and to the Data Processing Station, which furnishes much of the data used in the computations.

In the analog lab there is about $2\frac{1}{4}$ million dollars' worth of analog equipment, mostly Electronic Associates. This amounts to about 553 operational amplifiers and beaucoup output and auxiliary equipment.

In two adjacent rooms there is about $63,000 per month's worth of rental digital equipment which includes an IBM 704 and a 650 with all of the key-punch, tab machine, and other auxiliary equipment necessary for efficient operation.

Also in the analog laboratory are two DDA's, the Addaverter (which is the quarter-million dollar "translator" that allows the analog and digital computers to be used in combination) and a "central" patch-bay which will allow analog, digital, and data-processing equipment to be inter- and/or intra-connected.

The computer labs, which employ nearly 100 people, are administratively connected under Walter Varner and the computer and data-processing labs under Walter Schwidetzky.

Horwitz on Maintenance

Bob Horwitz, Analog Computer Group Engineer at Astronautics, next talked on equipment maintenance in his lab.

Bob's group consider their maintenance program important not just because it helps increase reliability and reduce costs, though these are tangible and well-recognized results, but more because of the less tangible and more important factor of opera-

tor confidence. In short, no confidence, no customers, no good!

Bob sketched a typical reliability curve which started at some finite value, rose rather steeply through a region A, leveled off through a region B, and then gradually declined through a region C.

The rise in A is the result of elimination of new equipment bugs, while at the same time the engineers, technicians, and operators are getting used to said equipment. The B region represents maturity of the equipment and the C, old age, involving wear-out and replacement with new components with reliability in the A region.

In the Astro analog laboratory they attempt to extend the B region by:

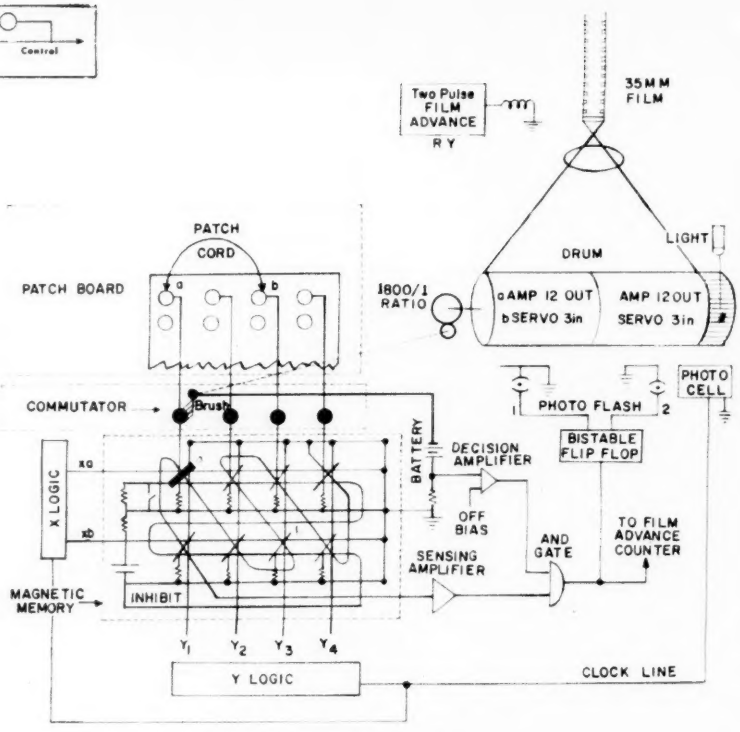
1. *Preventive maintenance* involving a morning checkout, which is in fact just a tolerance check, and various other routine checks and calibrations.

2. *Emergency maintenance* which involves having technicians in the area who unobtrusively hover over operators (operators don't like to call for help.*)

3. *Bench maintenance* in which units replaced for any reason are repaired and calibrated. Complete records are kept of this work, and if these indicate chronic weaknesses appropriate modifications are made. To facilitate this work there are specially-designed test benches for all major components—amplifiers, power supplies, servos and resolvers, electronic multipliers, and function generators.

Bob concluded by saying "Our rather extensive experience at Astro has taught us *not* to do certain things: (1) Don't handle the equipment more than necessary; don't plug or unplug unless you must. (2) Don't believe a tube checker. The best checker is the unit in which the tube is supposed to operate. (3) Rotational preventive maintenance is no good. We tried it in the San Diego Division, and our tube requirements went up by a factor of 10. Other failures went up by the same factor. (4) 90% of computer trouble is human; 9% tubes, diodes, and relays; 1% is miscellaneous."

*Because the trouble is most likely their fault—take it from this old operator.—Ed.



Astronautics Patch-Board Verifier

Bob then asked *Al Dinkle*, an engineer in the Analog Computer Group, to describe the Astronautics patch-board verifier.

Dinkle on Patch-Board Verifier

"The function of a patch-board verifier is primarily to catch human errors," Al began. "Not just errors such as getting a plug in the wrong hole, but errors like failing to record changes."

It is easy to see how the latter human shortcoming could play havoc with multi-shift operation. One shift makes a change for a special purpose—the next shift gets unexpected results. How come? The Astro patch-board verifier was designed to answer with a printed list of all connections in ten minutes although actually, because some components do not operate at specified speeds, it might take as long as thirty minutes.

Operation of the Astronautics patch-board verifier involves the following components:

1. The patch-board, having 1800 holes, or possible patching positions.

2. The patch-board receiver, with 1800 contacts.

3. An 1800-core memory with 45 x and 40 y drive lines, and 1800 individual core drive lines.

4. A commutator having 1800 segments each connected to one of the receptacle contacts and, through the individual core drive lines and resistors, to ground.

5. Scanning logic to successively energize all combinations of x and y memory-core drive lines.

6. A drum to generate "clock" pulses for the scanning logic, and to carry two identical columns describing the 1800 patch-board positions. It also drives the commutator through an 1800-to-1 mechanical linkage.

7. A camera and optical system to photograph the patch-board position descriptions on the drum.

8. A battery, decision amplifier, sensing amplifier, AND gate, bistable flip-flop, and two photoflash lights wired as shown in the diagram.

The operation of the verifier is based on the rather reasonable assumption that every patch-wire has two—and only two—ends, and that they are both supposed to be plugged in; dangling wires will not register.

So let us suppose that there is a patch cord from any patch-board position a, which may be the output of amplifier 12, to any position b, which may be the input to servo 3.

All memory cores are set to the "1" state at the beginning of each commutator cycle. When the commutator arm reaches a, two things happen:

SPEAKING WITH EASE®

An up-to-the-minute report on computer technology prepared by the **Beckman/Berkeley** *engineering staff*

In the October issue of "Speaking with EASE" we noted some points to consider when evaluating static accuracy and discussed recent techniques devised to improve the static accuracy of EASE computers. This month we will extend our examination to the dynamic accuracy of linear components.

New Importance of Linear Dynamic Accuracy

Two recent developments have increased the need for high linear dynamic accuracy. One is the appearance of speedy electronic multipliers and resolvers. In the past, sluggish servo equipment often placed so low a limit on computational frequency that high frequency linear accuracy was irrelevant. Now, high linear accuracy at frequencies up to 50 cps has become very important in non-linear as well as in linear problems.

Another stimulating development is the widespread adoption of statistical methods for investigating missile performance. In this application quick solutions requiring accuracy at frequencies of 20 to 50 cps are essential if one is to simulate hundreds of missile flights in a reasonable period.

How to Evaluate Linear Dynamic Accuracy

The major source of dynamic error in modern summing amplifiers is phase shift. Only one degree phase shift in a sinusoidal signal will create a maximum error of 0.87% of peak-to-peak voltage. In a high accuracy computer phase shift should be well below one degree—preferably only a few hundredths of a degree.

When examining phase characteristics, it is well to remember that most amplifiers will be used in conjunction with a coefficient potentiometer. Consequently, the critical characteristic is phase shift *from pot input to summer output* at the patchboard terminals. This deserves special emphasis because efforts to produce high stability, while not inimical to low phase shift in the summing amplifier itself, may create a large phase shift through the coefficient potentiometer.

How Ease Engineers Achieve Low Phase Shift

Phase shift at normal operating frequencies is caused by input and feedback resistances with differing a.c. characteristics. This can be overcome by obtaining resistors with carefully-controlled parasitic capacitance, then adding sufficient capacitance in parallel with each to produce equal time constants. Because equal time constants can be created with balancing input and feedback capacitances of almost any magnitude, the independent question arises as to how large the value should be. Here we find we must reconcile conflicting objectives. Stability will improve as the feedback capacity is increased up to a certain point (approximately 100$\mu\mu$f across 1M in the case of EASE amplifiers). On the other hand, as we raise input capacity to balance increased feedback capacity, we get a progressively larger phase shift through the coefficient potentiometer.

This situation calls for careful selection of an optimum value. EASE computer engineers have selected a value at which phase shift through the pot is approximately the same as possible phase shift through the summing amplifier itself. (Amplifier phase shift is due to variations in parasitic capacitance and compensating capacitance within component tolerances.) Optimum compensating capacitance for 1M input and feedback resistors turns out to be about 40$\mu\mu$f. This reduces maximum phase shift *from pot input to summing amplifier output* to within ± .02° at 10 cps with unity gain and any pot displacement from 0.15 to 1.0. Phase shift this low creates dynamic accuracy of approximately .02% at 10 cps. Possible error increases approximately linearly as frequency is raised.

The resultant stability is such that three typical amplifiers can be connected at the patchboard in a loop with loop gain raised to between 4 and 9 before oscillation occurs. Correspondingly, a single one-megohm inverter will not oscillate until output to ground capacitance exceeds 1μf.

A Simple Circuit for Testing Phase Shift

Phase shift can be tested by patching-in the three-amplifier oscillator circuit diagramed in figure 1. The frequency of oscillation can be set anywhere from approximately 1 cps to 50 cps by adjusting the potentiometer. If all operational components were perfect this circuit would create a sine wave of unvarying amplitude. Imperfections cause amplitude to increase or decrease slowly with time. Factors influencing this change are:

1. Phase shift from pot input to summer output.
2. Phase shift due to integrator input resistors.
3. Integrator capacitor dissipation.

Thus, the circuit affords a ready means of comparing analog computers with respect to these characteristics. Although the first factor cannot be easily isolated, a low rate of increase or decrease indicates that it, as well as the other two factors, is contributing very little error.

The EASE 1100 Series computer has been extensively tested by means of this oscillator circuit. Figure 2 shows the results of these tests.

For further information on linear dynamic accuracy write for Data File 302 "Extending the Bandwidth of Precision Analog Systems."

Beckman/ EASE COMPUTERS

Mfd. by Berkeley Division, Beckman Instruments, Inc., Richmond 3, California

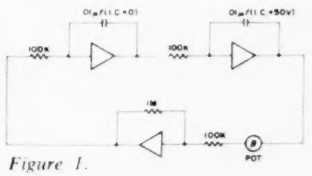


Figure 1.

Figure 1. A patched-in oscillator circuit for testing phase shift. A low rate of change in amplitude indicates low phase shift.

Figure 2. Performance of oscillator circuit shown in Figure 1 when patched-up on the EASE 1100 Series computer. Graph shows rate of change in amplitude at selected operating frequency.

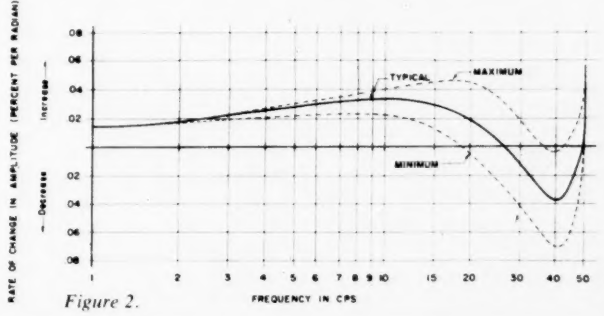
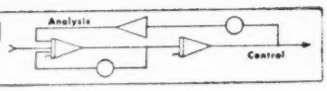


Figure 2.

C3

For more information circle **66** on inquiry card.



(1) current flows from the battery through contact a *and* contact b (because of the patch-cord) and through cores a and b, and their respective resistors to ground, and (2) because two paths are simultaneously energized, the decision amplifier energizes one-half of the AND gate.

Meanwhile the scanning logic is successively energizing all combinations of the x and y core drive lines in synchronization with the drum rotation. When x_a and y_a are simultaneously energized, the magnitude and direction of the currents in cores a and b are such that they, together with the current from the commutator, create a magnetic field strong enough to change the polarity of core a, thus causing a pulse in the sensing winding. This pulse, amplified in the sensing amplifier, energizes the other half of the AND gate, thus firing, through the flip-flop, one of the photoflashes just as the description of a, "Amp 12 out", is in position to be photographed by the camera.

Some time later, in the same scanning cycle, x_b and y_b will be simultaneously energized just as the description of contact b, "Servo 3 in", is in position to be photographed. This time, however, the flip-flop causes the *other* photoflash to operate, which places the image on the film in line with, but not on top of, the description of a, so that the line on the film will read "Amp 12 out Servo 3 in".

A counter, operating after each second gate pulse, then advances the film as the commutator arm is advanced by the drum linkage. However, when some time later the commutator reaches b *no sensing pulse* results because the b core has already been changed to the "0" state. Thus no record is duplicated.

Tuttle on EASE Checkout

Ken Tuttle, manager of the Beckman-Berkeley Los Angeles Computing Center, next described the EASE automatic checkout equipment installed at his facility. Ken's explanation of the static and dynamic checks, supported by blackboard sketches, was lucid and interesting to those not familiar with the EASE system. However, as the system has been previously described in the *Newsletter** and elsewhere in the literature we will not repeat it here.

*July 1956.

Warshawsky on Pseudology

Milt Warshawsky, who normally holds forth with the Midwestern Simulation Council, followed Ken on this Western program. Milt was invited to come out to California to participate in our discussion of "Is Your Computer A Pseudologist?" because of his extensive experience with such matters at Wright Air Development Center.

"Thank you for your invitation to meet with the Western Simulation Council," Milt began. "At WADC we are in an area to the left of area A on Bob Horwitz's diagram: an area in which we turn on the computer and fuses blow! I assume, Bob, that you were talking about a completely developed computer—ours is still under development."

Milt and his group were able to accomplish something many of us dream about. They convinced the "powers that be" that they couldn't expand the existing mixed facility satisfactorily. They were therefore able to start from scratch to design a large system to suit their particular requirements. The result is a nice-looking installation of four identical computers with four operating stations in the corners and a control station with the patch-board verifier.

Each station has two identical patch-boards of about 2500 holes and can be used autonomously or in combination with other stations.

The equipment, built by Reeves Instrument Company to Air Force specs, includes 160 integrators, 196 summers, 144 inverters (associated with other computer components, but available for computing), 50 servo multipliers (some with tapped pots for functional generation), 32 ten-segment diode function generators, 16 servo resolvers, and 24 electronic multipliers.

The electronic multipliers are of the square-law type, and incorporate a rather interesting feature. To improve the generation of the parabolic function beyond that obtainable by straight-line approximation, they superimpose a triangular wave dither voltage on the input. This gives perfect parabolic interpolation. Of course, in theory a perfect parabola would be obtained by using just a single diode and a triangular wave sweeping between 0 and 100 volts. Actually five diodes are used.

Milt referred to *Hans Meissinger's* paper on the generation of a function of two variables, saying they have that type, but have gone one step farther by providing for automatic setting of diode function generators by means of a Flexowriter or punched tape. This contract was let on 1 June 1955, Milt said, and the computer was to be completed and accepted by 1 June 1956. On 1 June 1957 they received the first station! The last shipment of equipment came in about the first of 1958 and they are still engaged in the process of finding bugs while Reeves makes like Henry with the Flit.

"We had been turning out computer solutions but we didn't know whether they were right or not," Milt continued. "Our only real check was to see if they looked reasonable. This doesn't induce long life and peace of mind.

"By way of contrast, I had been led to believe that digitals had built-in checks, and when they turned out solutions they could tell you about confidence factors, etc. This has not proved to be the case. We have had many instances in which we compared differing solutions and it turned out that the digital solutions were the ones that were way off. We are not in worse shape, and have not been in worse shape than the digital people."

Milt said that with their new computer they wanted to be sure their results were valid. They also wanted to be sure that the problem on the machine was one they wanted to solve, and they wanted to know whether they were using the computer in its optimum region. To these ends there are several special features.

On November 1, 1953 they built a prototype plug-board verifier, and were in business by March of '54. However, there are other ways an operator can go wrong besides plugging in the wrong hole.* A patch cord may be open electrically. Or, because they use shielded patch cords, there is the possibility of shorts between hot line and ground. Their verifier takes nine minutes to scan 500 cords and show such things. The length of time it takes to scan the entire board of course depends on the number of patch cords. A 2500-hole board with no cords takes 50 seconds to scan. Each cord present adds one second to the scanning time. A Clary adding machine is used for printing.

To further reduce human errors there is the *Reeves Problem Check*, an extremely powerful tool for determining that the computer elements are operating properly, that all pots are set correctly, that patch cords are connected properly, and that input

*Oh!??Ed.

resistors are right. This requires some previous desk calculator work. The Problem Check pots are servo-set by a Flexowriter tape, so that when the tape is once put in, the Problem Check pots are standing by with proper voltage and polarity. Any time the operator wants to check he pushes a button "PC", and he is back in Problem Check. The relays which hold the voltage are electrically locked and the power supply is maintained 24 hours a day, even if the line power fails or if the power is turned off the computer. This is to insure that the capacitor ovens will have constant power. If the capacitors are allowed to cool off drastically and are then reheated, the capacitance will be changed. There is also a capacity check similar to that mentioned by Tuttle in describing the EASE.

So that the operator can be sure he is working in the optimum region for the computer, there is a *Maximum Excursion Indicator*. This is a counterpart of the overload indicator we are all familiar with. Before this computer was built no one seemed to give attention to *under*load. Signals might be buried below noise. If it requires one minute per element to observe computer excursions and if there were 1000 elements to observe, one could spend several days in checking. Milt's method consists of a light associated with each element which stays on until the voltage level of each element reaches a bias value which has been set anywhere from zero to 50 volts. There are two such adjustments—one for servos, one for amplifiers. When the minimum is reached the light goes out. After a run the operator checks, and any lights still on indicate that the minimum threshold was not reached.

There is also a time-scale check to insure that no frequencies encountered in a solution are exceeding the capabilities of the servos. By flipping a switch the operator can slow problem solution time by a factor of two. Thus if a solution obtained at half speed checks with a normal solution, you can assume that the normal speed is satisfactory.

One of the very important things Milt's group wants to monitor is the reference supply. At each station there is a 100-volt error indicator; an unbalance of five millivolts is enough to cause lights to light, bells to ring, etc., etc.

A universal test stand which permits dynamic checking of components in the rack also has been received. For power supply checks they can move up a dummy load box, throw a switch on the power supply, phase the power into the dummy load, and determine whether the malfunction is due to the supply or the load.

The Flexowriter system provides a way to set scale pots, Problem Check pots, and diode function generators, and to read out the connections of the computer elements. In connection with pot readout, a tape is prepared which can later be used as a command tape so that pots can be reset to the value they had when they were read. These automatic features are primarily for the purpose of two-shift operation where the second shift is working on different problems.

Milt says that he is pretty well convinced that they can take a full-capacity problem off the computer and substitute another full-capacity problem, reset everything, submit the machine to problem check, and be ready to operate in less than an hour. A punched tape also can feed selected input voltages into the function generators and the outputs can be typed back for comparison with the desired ones. It is not necessary to use a plotting board to verify the function generator setup.

They have found it is the little things that require the closest check. The noise measurements and so forth were easy to make and fell within specs. The bugs were points you would never consider looking for. One of the biggest difficulties was that of reliability of patch-board contacts. It was necessary to make major modifications in these. The original plugs had nylon tips and an undercut contact area so that plugs could be changed while energized without danger of shorting against the grounded metal patch board. However, these proved unreliable, so it was necessary to sacrifice the safety of post-patching and go back to standard plugs.

The boards are big—six panels of Remington-Rand boards, each with 800-some holes, about half of which are used.

Irwin Pfeffer (Space Technology Laboratories, Los Angeles, Calif.) commented at this time that he had just figured that when the WADC computer reached the B portion of Bob Horwitz's reliability curve, they could expect about 10^7 micro-years at nearly 10^5 millipercent efficiency, but that it would take them about 5×10^{-6} megayears to get into production.

This broke up the meeting, so the group had coffee and then went on a tour of the computer facilities, where they were shown a simple demonstration of analog-to-digital-to-analog conversion with the Addaverter.

GPS ANNOUNCES

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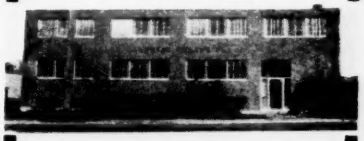

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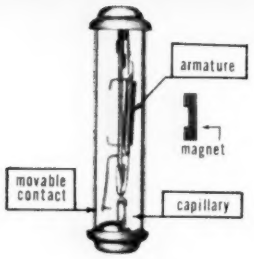
NEW miniature encapsulated

"MAGNETIC" MERCURY SWITCH



Actual Size

CAPILLARY TYPE MAGNET OPERATED MERCURY SWITCHES

Moveable contact in the hermetically sealed switch makes contact by penetrating opening in the capillary tube (see illustration). Capillary tube is positioned so as to be supplied by the mercury in the well.

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Adaptable to applications where a mechanical movement of approximately 0.007 (minimum) with a force of 2 grams is available to move the permanent magnet. Can be operated by small DC electromagnets for incorporation in electric or electronic equipment.

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ELECTRICAL CONNECTIONS

Electrical connections to switch are made through the metallic-end caps, eliminating lead wires attached directly to the switch. They are however, available with lead wires of various lengths.

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Type 6-81 normally open and Type 6-83 normally closed.

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Write for Bulletin 6-81

THE MERCOID CORPORATION
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For more information circle **68** on inquiry card.

Information (Without Theory)

Received a large tome from *Mark E. Connelly* of the Servomechanisms Laboratory of MIT entitled "Simulation of Aircraft", which is the result of a program sponsored by the U. S. Naval Training Device Center of Port Washington, New York. Your Editor is hardly a final authority on such matters, but it would seem that this is the most comprehensive treatment of the general problem of aircraft simulation available. Copies may be ordered from the Center.

We are also in receipt of *Le Calcul Analogique Par Courants Continus* by Danloux Dumesnils, who is a professor at the Ecole Nationale Supérieure de l'Aéronautique (Dunod, Editeur, 92, Rue Bonaparte, Paris). Your Editor can't read French and your Secretary is not proficient in Computer, so we can't say for sure, but it would seem from the illustrations that this is an excellent text on the analog computing art, sort of a French Korn and Korn.

He Went Thataway:

Bill Gunning to Epsco-West, 125 East Orangethorpe Avenue, Anaheim, California, where he is Technical Director.

Errata, or He Didn't Go Thataway:

We have a letter from Eric Weiss of the Sun Oil Company:

"I appreciate your recognition of the fact that I am with the Sun Oil Company at Newtown Square but, since I have been here for 13 years, I found the headline 'He Went Thataway' rather strange.

"Perhaps the fact that our names are the same has led you to confuse me with a recent employee of Daystrom at La Jolla. Although I believe that I can prove prior use of the name, I do not plan to make an issue of the matter and instead will try to minimize future confusion by signing myself as Eric A. Weiss."

Computer Events

Western Simulation Council

Date: 13 November 1958, 1:00 PM
Place: University of California at Los Angeles
Subject: "Applications of Analog Computers to Solutions of Field Equations"

American Rocket Society (annual meeting)

Dates: 1-5 December 1958
Place: New York, N. Y.

Western Joint Computer Conference

Dates: 3-5 March 1959
Place: San Francisco, Calif.

Midwestern Simulation Council

(a) Business Meeting, Tuesday, December 9, 1958, MAECON Show, Kansas City, Missouri.
(b) "Computers in Control" Monday, February 2, 1959, Tulsa, Oklahoma. Sponsor, Phillips Petroleum Company, L. H. Freeman, Technical Program Chairman.
(c) "Non Linear Control Systems" Monday, May 11, 1959, Manhattan, Kansas. Sponsor, Kansas State College, Charles J. Halijak, Technical Program Chairman.
(d) "Computer Administration, Environments, and Physical Facilities" Monday, October 5, 1959, St. Louis, Missouri. Sponsor, McDonnell Aircraft Company, Bruce H. Estes, Technical Program Chairman.

High-Speed Computer Conference

Dates: 10-13 February 1959
Place: Louisiana State University Baton Rouge, Louisiana

Southwest IRE Regional Conference and Electronics Show

Dates: 16-18 April 1959
Place: Dallas, Texas

National Aeronautical and Naval Electronics Conference

Dates: 11-13 May 1959
Place: Dayton, Ohio

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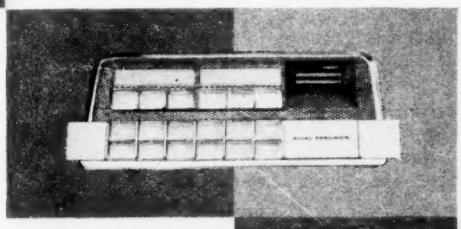

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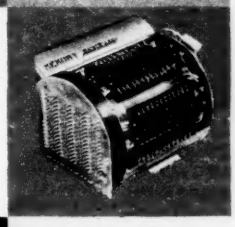

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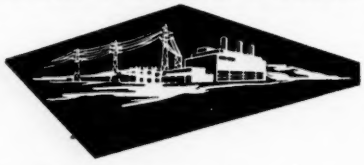

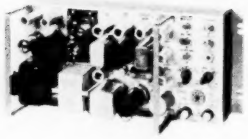

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Any communication link, including power line carrier, microwave or wire line may be used.

Over-all accuracy is 1% with a response speed of 1 second. Equipment features a built-in calibration circuit for 10% and 90% receiver check, and 10 cps and 30 cps transmitter check.

Any quantity which may be converted into a DC millivoltage or will operate a slidewire may be telemetered.

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new instruments

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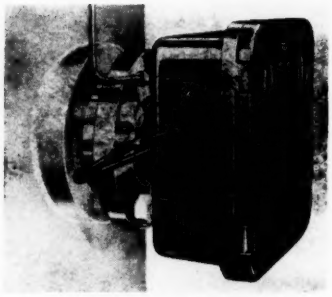
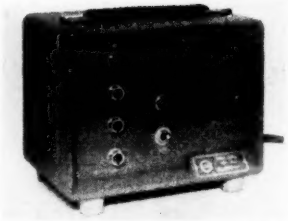
FLOATLESS LEVEL CONTROL



New Type 115 floatless liquid level controller handles corrosive or heavy viscous liquids as they come into contact only with the diaphragm and diaphragm ring. The Type 115 transmits a pneumatic output signal which is equal in magnitude to the head pressure resulting from the liquid in the vessel. When used for control, a Wizard II Type 4152 controller provides liquid-level and proportional-band adjustments with standard output pressures of 3-15 or 6-30 psig.—*Fisher Governor Co., Marshalltown, Iowa*

For more information circle **167** on inquiry card.

AUXILIARY POWER SUPPLY

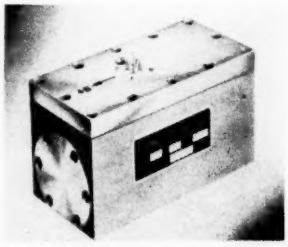


New all-transistor regulated Auxiliary Power Supply, Model 60A, provides external 12-volt d-c power for portable, battery-powered test instruments. Ripple is less than 200 microvolts and the d-c source impedence is less than that of a battery.—*Consolidated Electrodynamics Corp., Alectra Div., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **168** on inquiry card.

ACCELEROMETER

New Differential Transformer Accelerometer, Model 7-34, features high voltage output efficiency (to 60 volts in a range from ±1G to ±50G), infinite resolution, precision axes alignment, and a very low threshold sensitivity. Maximum nonlinearity is less than 1.0%; phase shift at zero deflection 0±5°.—*Edcliff Instruments, P. O. Box 565, Monrovia, Calif.*



For more information circle **169** on inquiry card.

SERIAL MEMORY PACKAGE

New transistorized Model SM-10 Serial Memory package has three basic sections: a driver circuit, a magnetic-strictive delay line, and an amplifier circuit. It is a delay unit with amplifiers and does not incorporate any logic. Its input is by a standard LE-10 Logical T-PAC or other logical circuitry. The output with assertion and negation is similar to an LE-10 package. Delays up to 560 usec are available in one SM-10 unit. Screwdriver adjustment provides ±1½ usec of delay.—*Computer Control Co., Inc., 92 Broad St., Wellesley, Mass.*

For more information circle **170** on inquiry card.

DIAPHRAGM PUMP

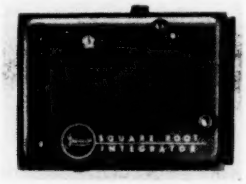
New low-volume Diaphragm Pump for delivering oil-free air offers vacuum up to 22" Hg, pressure up to

40 psi, and a maximum displacement of 0.85 cfm at free flow. Valve gasket and diaphragm are of neoprene-nylon. —*Air-Shields, Inc., Hatboro, Penna.*

For more information circle **171** on inquiry card.

SQUARE-ROOT INTEGRATOR

New Model 26 Square-Root Integrator automatically totals flow through standard flowmeters that utilize the output of conventional sensing elements. Double disc-and-ball integrating mechanism results in lin-

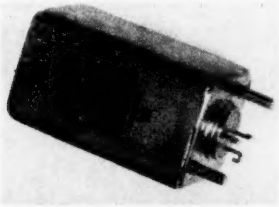


earity of 0.25% and repeatability of 0.05%, both of full scale. The integrator has an input shaft torque of 0.35 in-oz maximum and a shaft rotation of 18°30'. A pulse switch driven by the counter shaft provides information to remote counters, telemetering or data handling systems.— *Librascope, Inc., Commercial Div., 40 East Verdugo Ave., Burbank, Calif.*

For more information circle **172** on inquiry card.

NARROW-BANDWIDTH FILTERS

New Type FP2 filters are two resonator networks designed as vacuum-tube-coupling circuits where relatively narrow bandwidth is desirable. FP2A filters operate from a typical triode amplifier or any other source



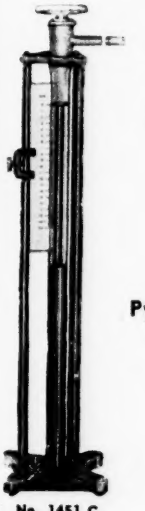
of approximately 10 kohms into a grid. FP2B filters operate from a typical cathode follower or other 500- to 600-ohm source into a grid. Toroidal inductors are used for linearity and freedom from stray field effects.—2-page Bulletin FP2 contains details.— *White Instrument Labs., Box 9006, Allandale Station, Austin 17, Texas*

For more information circle **173** on inquiry card.

DUBROVIN VACUUM GAUGES

Made expressly by WELCH
For Moderately Reduced Pressures

Sensitive - Compact
Practical



Range: 0.2 mm To 20 mm of Hg

•

Far More Sensitive Than Mercury Manometer

•

Two Sensitivities Available

•

Pyrex-Brand or Soft-Glass Construction

No. 1451 C. Table Mounting

No. 1451 H. Wall Mounting

EASY TO INSTALL - CONVENIENT TO USE

The Welch-Dubrovin Gauges are made in two basic types. One 9 times and the other 6 times as sensitive as a mercury manometer. Because of this "magnifying factor," the gauge is as sensitive as a manometer which uses a liquid of low density, but has the advantage of using mercury which dissolves very few organic or inorganic vapors and which requires no conversion factor. Unlike mechanical or optical magnifying devices, any small errors due to capillarity, adhesion, etc., are not magnified. The smallest division on the 9-to-1 type is 0.2 mm and on the 6-to-1 type is 0.5 mm of Hg. Fractions of these values may be estimated. Both types are available with Pyrex-brand or soft glass in either table or wall mounting.

PRICED AT $47.50 AND $55.00

WRITE FOR COMPLETE LITERATURE.

IF YOU DO NOT HAVE OUR VACUUM PUMP CATALOG WRITE FOR IT.

W. M. WELCH SCIENTIFIC COMPANY

DIVISION OF W. M. WELCH MANUFACTURING COMPANY

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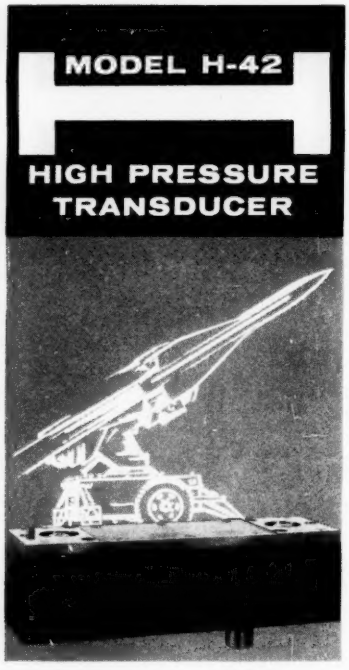
1515 Sedgwick Street, Dept. B, Chicago 10, Illinois, U.S.A.

Manufacturers of Scientific Instruments and Laboratory Apparatus

For more information circle **71** on inquiry card.



In each Hawk missile launcher developed by Northrop Aircraft Inc., two Servonic H-42 pressure transducers provide damping in the servo systems which operate the azimuth and elevation controls. A radar impulse furnishes guidance and slews the missile carriage to the proper position for launch. The Servonic transducer senses the pending oscillation in the hydraulic system due to the inertia of the moving mass and applies a correction signal to the servo amplifiers controlling hydraulic pressure so that each oscillation is counteracted. This provides a stable motion as the platform is brought to rest in the correct firing attitude.

The use of the H-42 in the Hawk launcher servo systems is typical of the many application capabilities of Servonic pressure transducers in extreme environmental situations.

H-42 SPECIFICS:

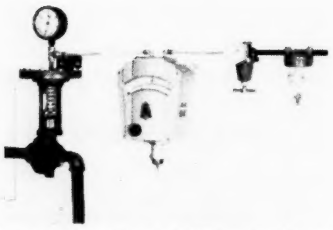
Range: ±4,000 psid.
Linearity: ±0.5%.
Hysteresis: Less than 1%.
Resolution: 0.2%.
Vibration Effects: Less than 1% at 20g.
Shock: 30g.

Complete Details in
Technical Bulletin ST-3

SERVONIC
INSTRUMENTS, INC.
640 Terminal Way
Costa Mesa, California

For more information circle **72** on inquiry card.

INDICATING AND RECORDING CONTROLLER

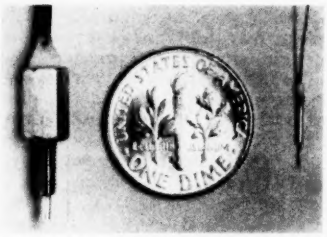


For more information circle **174** on inquiry card.

New pneumatic, mercury-actuated indicating controller (illustrated) features adjustable throttling range, (3 to 20%) and a built-in failsafe device to shut-down the air valve in case of failure of air supply.—Detailed specifications are contained in Bulletin 342.—★ New Model RVA pneumatic recording temperature controller for industrial applications featuring a 10" circular chart and adjustable throttling range, (3 to 20%) is actuated by a mercury-filled thermal element.—Bulletin 242 contains details.—*The Partlow Corp., 508 Campion Rd., New Hartford, N. Y.*

MINIATURE SURFACE TC

New coaxial thermocouples, 0.015" in diameter, to measure surface temperatures of metal walls with less than one microsecond delay, are threaded or clamped in the wall so that the thermal junction is aligned with the surface. In the Pt/Pt-Rh type a platinum-rhodium alloy can be used simultaneously as the protection tube.—*The Motech Co., Box 6009, Kansas City 10, Mo.*



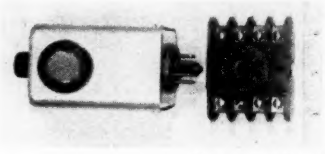
For more information circle **175** on inquiry card.

DIGITAL BUILDING BLOCKS

New transistorized Digital Systems Building Blocks for both high and low frequency have compatible signals, thus permitting both type units in one system. High frequency units will operate at any frequency up to 5 megacycles.—*Digital Equipment Corp., Maynard, Mass.*

For more information circle **176** on inquiry card.

PHOTOCELL CONTROL SWITCH

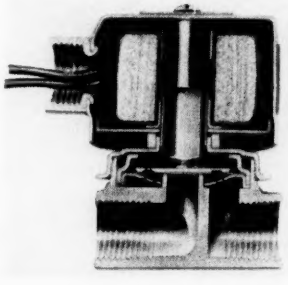


New Model R Photorelay incorporating hermetically-sealed cadmium sulfide cell and quick-acting DPDT relay with contacts rated at 5 amps, 120 vac has fully-adjustable sensitivity.—*Berkeley Dynamics, 2831 7th St., Berkeley 2, Calif.*

For more information circle **177** on inquiry card.

SOLENOID VALVES

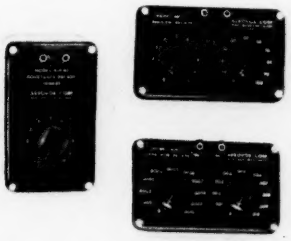
New valves of ⅛" and ¾" port diameters round out Series J Solenoid Valves for complete range from ⅛" to 1½" port dia, featuring pilot operation and only two moving parts. They are being used for low-cost flow control of water, air, low-pressure steam, light oils, brines, industrial and L.P. gasses and other noncorrosive fluids.—*Jackes-Evans Mfg. Co., Controls Div., 4427 Geraldine Ave., St. Louis 15, Mo.*



For more information circle **178** on inquiry card.

DECADE BOXES

New line of Decade Boxes, comprising 3 capacitance models, 3 resistance models, and 4 inductance models; has



heavy duty construction for long, trouble-free operational life.—*Aerovox Corp., New Bedford, Mass.*

For more information circle **179** on inquiry card.

MAGNETIC AMPLIFIER

New Model 701 Relay Amplifier operates on less than 3 microwatts from low-energy d-c sources such as photoelectric cells, null detectors, and ther-

mocouples, and delivers 0.4 watts output; or from 26 v at 400 cps for aircraft, etc.; with excellent reliability and good sensitivity.—*Acromag, Inc., 22519 Telegraph Rd., Detroit 41, Mich.*

For more information circle **180** on inquiry card.

MASER AMPLIFIER

New Versitron, a low temperature, solid-state, maser amplifier for operation at microwave frequencies in either S-band or X-band, specially designed for radar, telemetry and communications research, development,

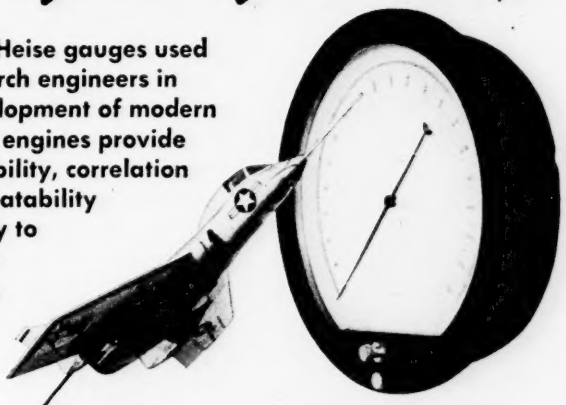
and field test applications will substantially improve noise figures or thermal threshold. Noise temperature of the Versitron is approximately 25°K; gain bandwidth products are 3 mcps at S-band and 10 mcps at X-band. It features circulator (waveguide) input and output, liquid helium operating temperature, and a stabilized magnetic field.—*Advance Industries, Inc., 640 Memorial Drive, Cambridge 39, Mass.*

For more information circle **181** on inquiry card.

HEISE GAUGES

Conquest of the Sky

Heise gauges used by research engineers in the development of modern turbo-jet engines provide the reliability, correlation and repeatability necessary to scientific progress.



Actual operating conditions are reproduced in the Cox Test Stand built by Commercial Research Laboratories to test for optimum efficiency of jet fuel nozzles.

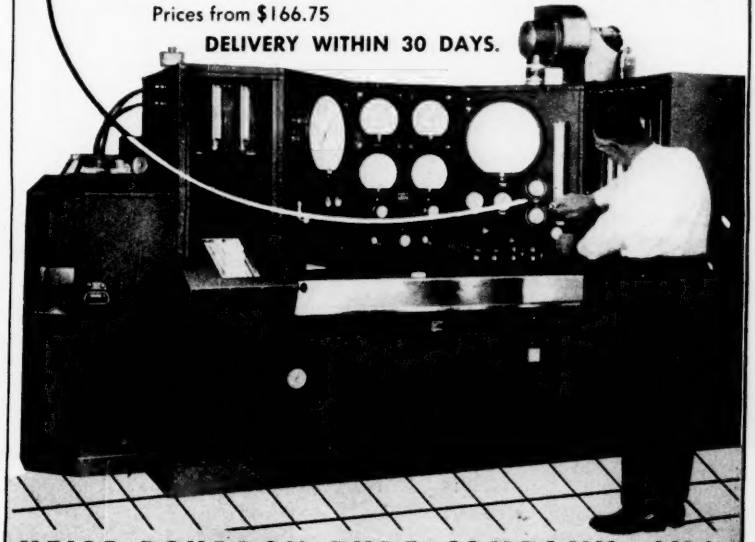
The six Heise gauges incorporated in the test stand feature in the vital and exacting performance which this instrument must accomplish.

Higher air speeds, rates of climb and economic fuel consumption, factors which every day reach and surpass new levels of efficiency, are made possible by the continuing efforts of research men equipped with today's most accurate instruments.

Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"-12"-16"

Prices from $166.75

DELIVERY WITHIN 30 DAYS.



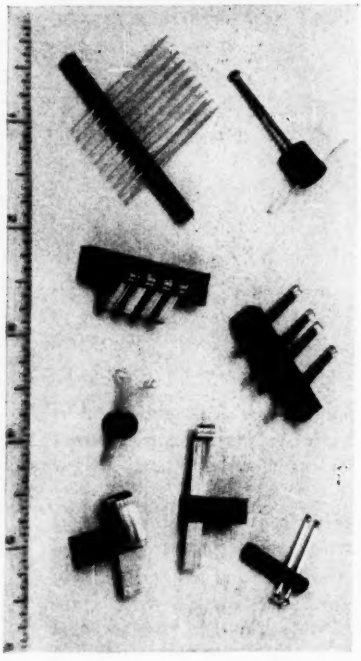
HEISE BOURDON TUBE COMPANY, INC.

BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **73** on inquiry card.

announcing

NEY MOLDED CONTACT ASSEMBLIES



Impressive cost savings and greater reliability are inherent in the use of the new Ney molded contact assemblies. For use with printed commutators, potentiometer windings, slip ring assemblies and printed rotary switches, these assemblies are available in a standard line now being manufactured by Ney, or can be designed to customer specifications.

Seven prime advantages are (1) a complete single or multiple brush assembly ready to use, (2) no welding or soldering, (3) reduction of adjustment during assembly into unit, (4) insured uniformity of desired gram pressure, (5) reduced inspection costs, (6) time tested Ney alloys for reliability, (7) will withstand extremes in operating environments.

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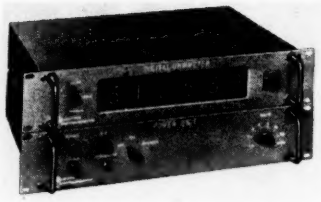
NEY

The J. M. Ney Company

P. O. Box 990, Dept. F, Hartford 1, Conn.

For more information circle **74** on inquiry card.

DIGITAL OHMMETER

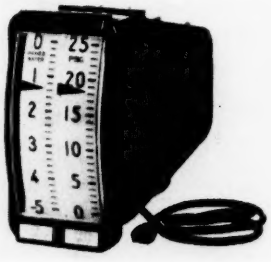


New five-digit Ohmmeter DOA-500, consisting of Universal Power Module and a Resistance Switch Module, is totally transistorized and is part of a complete new line of modular digital instruments. Accuracy is 0.01%, ± one digit, from 000.01 ohm to 9.-9999 megohms. Ranging is automatic. Average readout time is only 1.5 sec. —*Electro Instruments, Inc.*, 3540 *Aero Court, San Diego* 11, *Calif.*

For more information circle **182** on inquiry card.

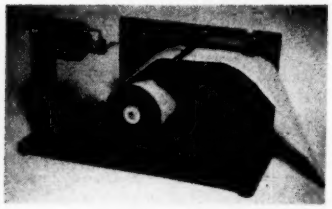
MULTIPOINTER GAGE

New 7-inch illuminated Multi-Pointer Gage Unit measures, transmits, and receives pressure, draft, differential, and level. Measuring elements are diaphragms, bellows or bourdon tubes, depending on range. Standard ranges from 0-0.5" W.C. to 0-5000 psig are available. Any number of gage units may be mounted adjacent on the same panel to provide multiple indications.—*Bailey Meter Co.*, 1050 *Ivanhoe Rd., Cleveland* 10, *Ohio*



For more information circle **183** on inquiry card.

STRIP CHART OSCILLOGRAPH



New Model ER-22 direct-writing oscillograph records signals from dc to 60 cps on electro-sensitive paper eliminating inking problems. A wide range of chart speeds is achieved by simple, inexpensive clip-in motors.—*Mandrel Industrial Instruments*, 5134 *Glenmont Dr., Houston* 36, *Texas*

For more information circle **184** on inquiry card.

LOCK WASHER TERMINALS

New lock washer terminals are manufactured from 0.018" brass or phosphor bronze, hot tinned, with #4, #6 and #8 holes. Free-samples kit available.—*Zierick Mfg. Corp.*, 110 *Beechwood Ave., New Rochelle, N. Y.*

For more information circle **185** on inquiry card.

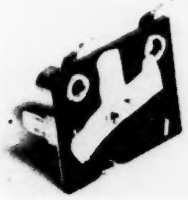
V-O-M/CLAMP-ON AMMETER

New Model 100 Volt-Ohm-Milliammeter and Clamp-On Ammeter Set includes (1) Model 310 hand-sized V-O-M which checks a-c and d-c volts (dc at 20,000 ohms/v), megohms, microamps and milliamps.) (2) a Model 10 Adapter which attaches to the top of the V-O-M (this clamp-On Ammeter checks line loads instantly). (3) A line Separator, Model 101, to divide two-conductor cords, and (4) adapter leads.—*The Triplett Electrical Instrument Co., Bluffton, Ohio*

For more information circle **186** on inquiry card.

GROUNDING SWITCH

New GS-1 Grounding Switch features twist-tab type mounting instead of threaded bushings or lugs. It is ex-

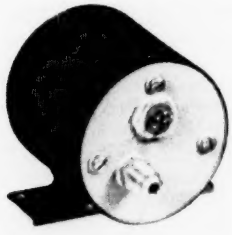


ceptionally simple and rugged in design; has been tested for 5000 rotational cycles or better.—*P. R. Mallory & Co., Inc., 36 S. Gray St., Indianapolis 6, Ind.*

For more information circle **187** on inquiry card.

PRESSURE PICKUPS

Three new pressure pickups: (1) Model 22005 for high-sensitivity absolute pressure measurements features

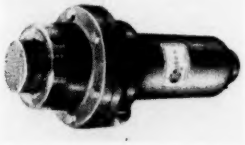


resolution 0.0002 or less, hysteresis better than 0.3%, repeatability better than 0.3%, high-temperature operation, low vibration and steady-state acceleration error. (2) Model 22008 is designed to measure pressures in extreme environments; (3) Model 22002 provides non-linear functions; both have a temperature range from −54°C to 100°C with performance that will not vary more than 1% over rated range at 100°C.—*Technology Instrument Corp. of California, 7229 Atoll Ave., N. Hollywood, Calif.*

For more information circle **188** on inquiry card.

FLOW REGULATOR

New Type F Flow Rate Regulators operates with differential of less than 10 psi, requires no outside source of power, and controls flow to within 3% of set point, regardless of fluctuations in line pressure. Available in carbon steel, type #316 stainless, and special alloys for flows from 0.02 to 550 gpm, with rangeability of 15 to 1.—*The W. A. Kates Co., 430 Waukegan Rd., Deerfield, Ill.*

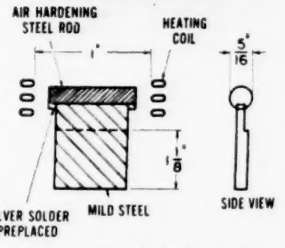


For more information circle **189** on inquiry card.

LepeL
HIGH FREQUENCY
INDUCTION
HEATING
UNITS
BRAZING
HARDENING
SOLDERING
ANNEALING
BOMBARDING
MELTING
The Lepel Line of induction heating equipment represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating.
If you are interested in induction heating you are invited to send samples of the work with specifications. Our engineers will process and return the completed job with full data and recommendations without any cost or obligations.

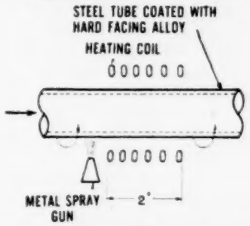
TYPICAL INDUCTION HEATING APPLICATIONS

SIMULTANEOUS HARDENING and BRAZING

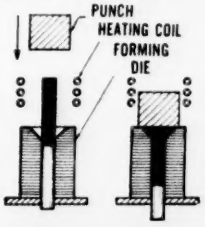


The machined and finished rod of air-hardening steel is simultaneously hardened and brazed to a mild-steel tab. Use of a purified hydrogen atmosphere and a high temperature brazing alloy permits successful hardening of alloy steels without discoloration and scaling even in the absence of flux.

DIFFUSION BONDING OF SPRAYED METAL COATINGS



Corrosion or wear resistant .metal coatings sprayed on metal surfaces can be improved by heating to achieve alloying by diffusion. The drawing shows a typical arrangement for processing steel tube sprayed with hard facing alloy. Long tubes may be progressively sprayed and heated.



HEATING HIGH STRENGTH ALLOYS FOR FORMING

Uniform and rapid heating of high strength alloys (alloy steels, titanium, etc.) aids in upsetting and forming operations and also minimizes oxidation and embrittlement.

Electronic Tube Generators from 1 kw to 100 kw.
Spark Gap Converters from 2 kw to 30 kw.

WRITE FOR THE NEW LEPEL CATALOG — 36 illustrated pages packed with valuable information.

All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.

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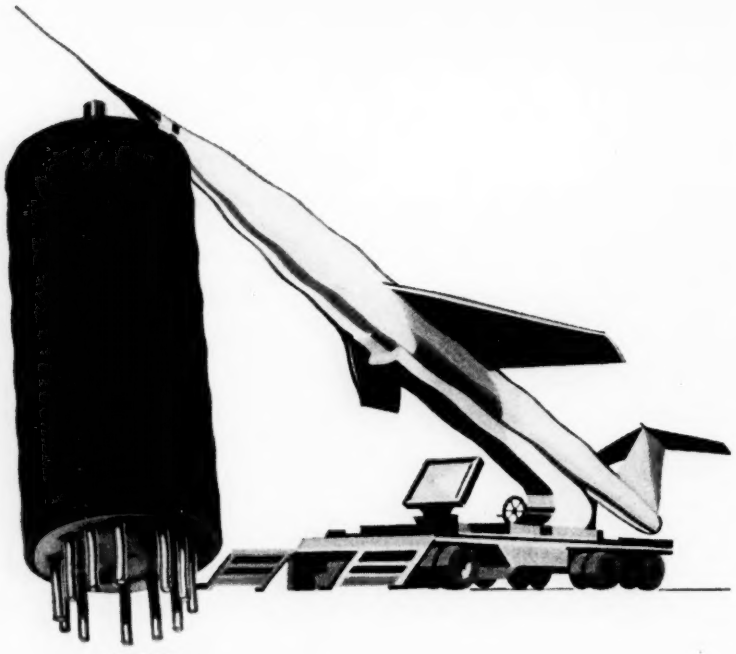
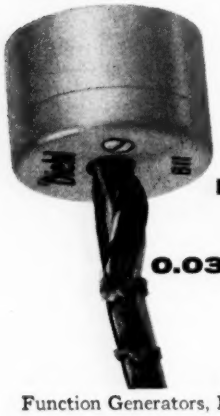




DIEHL*

SIZE 11 RESOLVER REACHES NEW STANDARD OF ACCURACY

0.03% TOTAL FUNCTIONAL ERROR

Missile guidance today requires more accurate Function Generators, Data Transmitters and Phase Shifters.

The DIEHL Size 11 Resolver is an answer to these problems.

DIEHL engineering and exceptional manufacturing methods insure a *uniformity* of product with a great percentage of the total production well within the 0.03% Total Functional Error. DIEHL defines percentage of Total Functional Error (T.F.E.) as: theoretical sine minus Actual Reading divided by sine 90° multiplied by 100.

A recent statistical check of one standard DIEHL resolver shows:

74% with T.F.E. less than 0.020%
22% with T.F.E. from ..... 0.020% to 0.025%
4% with T.F.E. from ..... 0.025% to 0.03%

This kind of quality eliminates the risk of culling special units from regular production.

All DIEHL standard units are available within 10 days. We invite your inquiries.

DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING COMPANY
Finderne Plant, SOMERVILLE, N. J.

Other available components:
A.C. SERVOMOTORS • A.C. SERVOMOTORS WITH A.C. TACHOMETERS
A.C. SERVOMOTORS WITH D.C. TACHOMETERS • A.C. AND D.C. TACHOMETERS
D.C. SERVO SETS • RESOLVERS

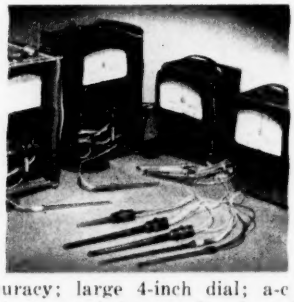
*A Trademark of DIEHL MANUFACTURING COMPANY

For more information circle **76** on inquiry card.

NEW INSTRUMENTS

THERMISTOR-ACTUATED THERMOMETERS

New high-sensitivity thermistor-actuated thermometers can be used remotely hundreds of feet away from probe with no effect on indication

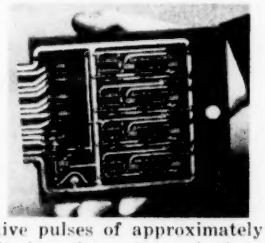


accuracy; large 4-inch dial; a-c or battery operated; rugged probes withstand pressure, shock or vibration.—*Marshall Instruments, Inc.*, 14203 *Bessemer St., Van Nuys, Calif.*

For more information circle **190** on inquiry card.

TRANSISTORIZED COUNTER

New Decimal Counter on a single plug-in card provides a four-line 1-2-4-8 output code, with 4 milliamps drive available directly from each of these lines. Designed to operate from



negative pulses of approximately 2 v amplitude and 1 to 2 usec in duration, and at operating speeds from 0 to 150 kc, all inputs and outputs are provided through a single 18-tab printed-circuit connector.—*Navigation Computer Corp.*, 1621 *Snyder Ave., Phila. 45, Pa.*

For more information circle **191** on inquiry card.

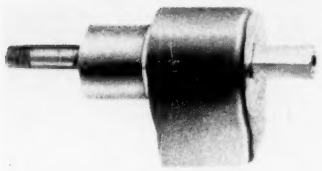
HEAVY-DUTY MOTOR

New instantly-reversible 80-in-oz continuous-duty synchronous motor, Series RSM, with output speeds from $\frac{2}{3}$ to 3600 rpm is $2\frac{1}{2}$" in dia, and

$1\frac{3}{4}$" long. Motor remains operative from −40°C to +105°C, and withstands 100g shock. Accurate synchronization is maintained during vibrations of 10 to 55 cps at 0.065" excursion.—*Hurst Mfg. Co., Princeton, Ind.*

For more information circle **192** on inquiry card.

HIGH-PRESSURE PACKLESS SOLENOID VALVES

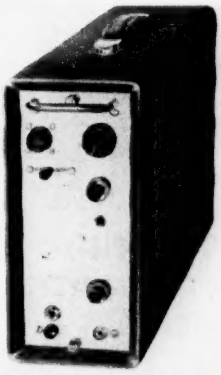


New high-pressure, 2-way, packless Solenoid Valve GV60-565 controls air and gases to 2500 psig, and liquids to 1800 psig. The valve is available with Nema I, Nema IV, or Nema VII, IX and IXA solenoid enclosures, ¼" N.P.T. or A.N.D. connections, and standard, threaded or A.N. electrical connections.—*Automatic Switch Co., Florham Park, N. J.*

For more information circle **193** on inquiry card.

DC COUPLING PREAMPLIFIER

New Model 450-1300 DC Coupling Preamplifier is a moderate-gain, balanced-input balanced-output d-c amplifier, which will perform equally well with single-ended or balanced signals. A three-stage circuit features cathode follower input and output, with over-all gain provided by the second stage push-pull transistor amplifier. Input is single-ended or push-pull, impedance 5 megohms each input side to ground; 50-mv input produces 1 volt at output jack under maximum output load conditions. Frequency response is 0-10 kc, linearity ¼%.—*Sanborn Co., Industrial Div., 175 Wyman St., Waltham 54, Mass.*



For more information circle **194** on inquiry card.

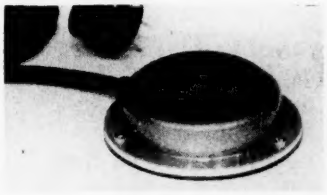
CONTACT ASSEMBLIES

New molded assemblies for use with printed commutators, potentiometer windings, slip ring assemblies, and printed rotary switches are available as standard line or made to customers' specifications. Advantages are elimination of welding or soldering, uniformity of desired gram pressure, reduced inspection costs, and others.—*The J. M. Ney Co., P.O. Box 990, Hartford 1, Conn.*

For more information circle **195** on inquiry card.

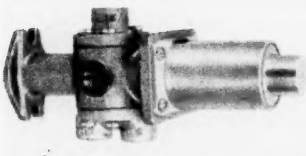
FOOT SWITCH

New improvements to Cadet Foot Switch give the operator better control from any angle. Overtravel stop ring allows operator to step on the switch at any point, and with any degree of force without any possible damage.—*Linemaster Switch Corp., 432 Woodstock Ter., Woodstock, Conn.*



For more information circle **196** on inquiry card.

3000-PSIG SOLENOID VALVES



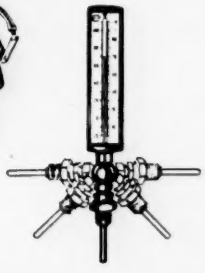
New Shear-Seal Valves for pressures up to 3000 psig with d-c solenoid operation from 12-, 24-, or 125-v sources are available in four-way, three-way, shut-off and diverter flow patterns.—*Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.*

For more information circle **197** on inquiry card.

on the *Skipjack*

Weksler Instruments

for temperature



pressure and humidity

Designed, engineered and manufactured for the finest . . . Weksler Instruments insure that any system is a better system!

Specify Weksler for your instrument requirements. Write for the Weksler catalogs . . . and use our advisory services without obligation.

WEKSLER INSTRUMENTS

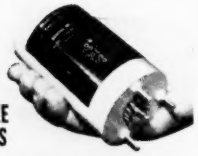
Photograph courtesy of General Dynamics Corp

WEKSLER INSTRUMENTS CORP.
FREEPORT, L. I., NEW YORK

For more information circle **77** on inquiry card.

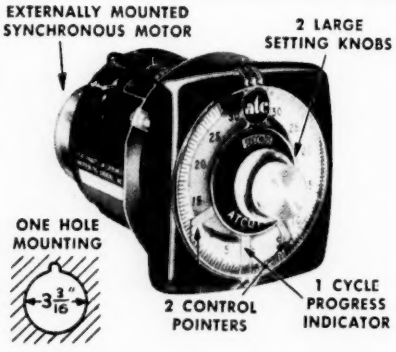
NEW DEVELOPMENTS IN

atc® TIMING CONTROL



MISSILE TIMERS

ATCOTROL MINIATURE RESET TIMERS



NOW...

TWO COMPLETE REPEAT CYCLE TIMERS IN ONE MINIATURE CASE

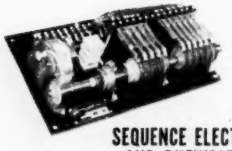
Designed to control two separate circuits consecutively, the Atcotrol Duo-Set is a miniature masterpiece of simplicity, accuracy (1/4% of scale) and dependability.

It embodies features usually obtained only in highest priced timers. For example, the motor reverses to change direction of the cycle progress pointer. This permits change in control point setting during the cycle and eliminates excessive mechanical parts. Load contacts are rated at 10 amps, 115 volts.

Duo-Set Timers incorporate all the service-proved features of the Atcotrol design . . . easily mounted, quickly removed for inspection while operating, self-cleaning contacts, fully protected one-piece compression molded terminal block and one-piece tubular rolled laminate slip-off cover.

VERNIER SET AND CYCLE PROGRESS TIMERS

ELECTRONIC TIMERS



SEQUENCE ELECTRIC AND PNEUMATIC CAM TIMERS

DELAY TIMERS

WORLD'S LARGEST PROCESS TIME CONTROL

TEN STANDARD DIAL RANGES

15, 30, 60, 120, 240 seconds
15, 30, 60, 120, 240 minutes

Write today for Bulletin No. N-80. Free demonstration on request.

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For more information circle **78** on inquiry card.

MULTI-CONDUCTOR CABLE

New multi-conductor cable has 102 mil overall dia, while conventional Teflon multi-conductor cable has a 125 mil overall dia. Available from #28 through #18 AWG with 1, 2, 3, and 4 conductors.—*Inso Products, Ltd., 404 Fifth Ave., New York 18, N. Y.*

For more information circle **198** on inquiry card.

GAS DETECTOR

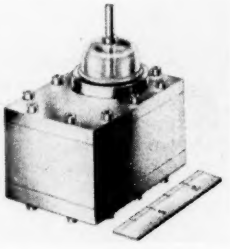
New imported Drager Gas Detector serves for making semi-quantitative gas estimations by non-skilled person. Detector tubes containing uniform amounts of different reagents are discolored by the gases in the air

to be tested, which are forced through the detector tube by a pump. Suction strokes of pump and color of the detector tube give indication of concentration of gas either directly on the detector tube or on a corresponding table.—*Union Industrial Equipment Corp., 20 Davis Ave., White Plains, N. Y.*

For more information circle **199** on inquiry card.

VIBRATING CAPACITOR

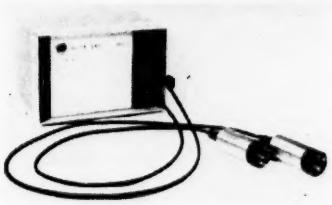
New Vibrating Capacitor VC-713/500 is a vibrating-reed type capacitance modulator used to convert d-c into sinusoidal a-c. It can measure



currents of 10^{-16} amp from a very high impedance source. Virtually free from drift it is suitable for mass spectrometry, circuits for measuring insulation resistance and dielectric leakage currents, pH, radioactivity, and output of ionization chambers.—Catalog 523 with price list gives details.—*Stevens-Arnold, Inc. 22 Elkins St., South Boston, Mass.*

For more information circle **200** on inquiry card.

NON-CONTACT CONTROL UNIT

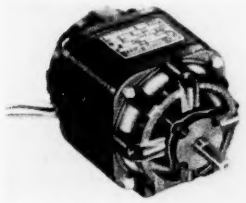


New Model 902-1 Delta Unit measures pressure, temperature, vibration, etc. by converting even minute capacitance changes into a phase-sensitive differential d-c voltage. Based on the patented T-42 ionization transducer the unit accepts initial capacitances from 1 to 50 $\mu\mu$F and provides maximum signals of $\pm$30 vdc.—*The Decker Corp., Bala Cynwyd, Penna.*

For more information circle **201** on inquiry card.

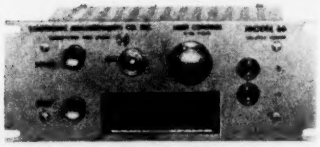
SUB-FHP MOTOR

New Type R-29 is made in 2- and 4-pole design and 3 frame lengths. Included are induction, reluctance synchronous, and hysteresis synchronous permanent split capacitor motors built in ratings from 1/150 to 1/20 hp.—*Holtzer-Cabot Motor Div., National Pneumatic Co., Inc., 125 Amory St., Boston 19, Mass.*



For more information circle **202** on inquiry card.

VOLTAGE LIMITER

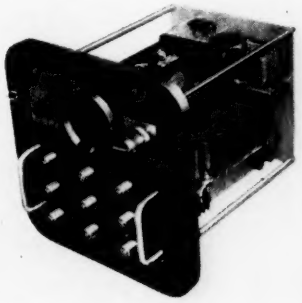


New instantaneous, all-electronic Voltage Limiter for power supplies with ratings up to 3-amp is used to protect transistors, and other voltage-sensitive devices from damage due to low- or high-speed voltage excursions. The limiter is adjustable between 0 and 50 v.—*Electronic Measurements Co., Inc., Eatontown, N. J.*

For more information circle **203** on inquiry card.

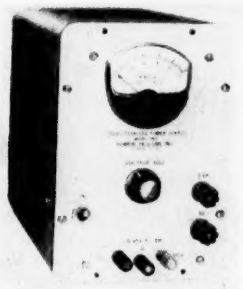
DIGITAL INDICATOR

New explosion-proof, multi-channel Digital Indicator, Type 6, is available as three- or four-channel model with manual or automatic switching between channels. Range is up to 9000 counts with ¼% accuracy. Unit contains a tuning-fork-controlled frequency standard for calibrating to various transducers. Two calibration ranges are available: 60-600 cps and 120-1200 cps.—*Cox Instruments Div., George L. Nankervis Co., 15300 Fullerton Ave., Detroit 27, Mich.*



For more information circle **204** on inquiry card.

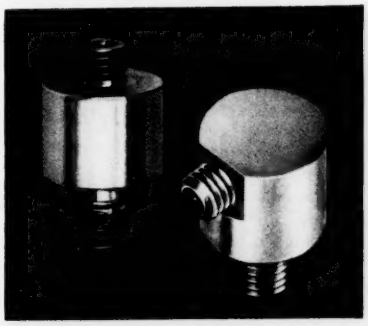
TRANSISTORIZED POWER SUPPLY



New portable Model 1515 is protected by Robotec, a transistorized electronic circuit, producing simultaneous current and voltage cutoff upon external short circuit. Operating in 30 usec, it reduces line input power to a negligible value and holds the power supply cut off until manually reset. Range is 1-15 vdc, 0-1.5 amps, regulation is better than 15 mv or 0.05%, ripple is less than 500 microvolts, source impedance is 0.01 ohms. —*Power Designs, Inc., 89-25 130th St., Richmond Hill 18, N. Y.*

For more information circle **205** on inquiry card.

Avoid false test results with GLENNITE internally ungrounded accelerometers



Now you can avoid one of the major causes of false test results – spurious "ground loop" voltages – by using *internally ungrounded* GLENNITE accelerometers.

These units contain sensitive seismic elements *internally* insulated from the mounting stud by rugged ceramic insulation. You can employ a *single point ground* at the data handling or recording equipment by using a combination of these accelerometers with ungrounded GLENNITE amplifiers and filters.

GLENNITE accelerometers are available in uni- and triaxial models – wide acceleration and temperature ranges.

A complete line of associated ungrounded electronic equipment includes filters, amplifiers, connectors and other related units.

For complete data on Gulton instrumentation systems – grounded or ungrounded – contact your local Gulton representative or write us direct.

Call in Gulton

From transducer to readout, Gulton is capable of meeting all your instrumentation needs. If you have a measurement problem, why not call in a Gulton Instrumentation Engineer. His broad experience in shock and vibration measurement can prove invaluable to you.

GULTON INSTRUMENTATION DIVISION

Gulton Industries, Inc.
Metuchen, New Jersey

For more information circle **79** on inquiry card.

More Accurate Level Reading of LOW TEMPERATURE LIQUIDS . . .

JERGUSON
Large Chamber
NON-FROSTING* GAGES

YOU get the highest possible accuracy of reading on low temperature, low boiling point liquids with the patented Jerguson Non-Frosting Gage in the New Large Chamber model . . . because it insures less turbulence at the meniscus, and clear vision at the vision slot.

This new Jerguson model has 6 times larger area at the meniscus than the standard gage, so that there is a marked reduction in turbulence with light gaseous fluids that tend to boil or surge. Moreover, the problem of frosting encountered with these liquids has been eliminated by a patented frost preventing unit extending from the gage glass. This special transparent unit projects beyond the cover bolts and prevents frost from building up over the vision slot.

Here's a dual feature gage that assures greatly increased accuracy of reading for the process industries. If you have a problem with light gaseous fluids, or with gage frosting, it will pay you to investigate the new Jerguson Large Chamber Non-Frosting Gage . . . reflex or transparent.

Jerguson Large Chamber Gage, Transparent Type, with the patented Non-Frosting Gage Glass Extension. Write for literature on this gage, and on other non-frosting Jerguson models.

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Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
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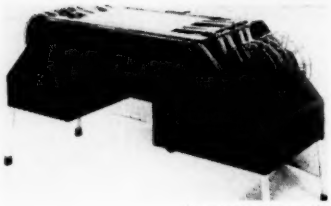
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

For more information circle **80** on inquiry card.

FILM COMPARISON VIEWER

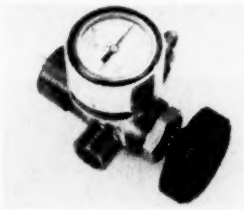


New Viewer for inspection and comparison of nearly identical reels of 35-mm film has forward and reverse speeds up to 300 ft/min. and rewind speeds up to 1000 ft/min. Operates from a 115-125 v, 60-cps, single-phase power source.—*Coleman Engineering Co., Inc., 3500 Torrance Blvd., Torrance, Calif.*

For more information circle **206** on inquiry card.

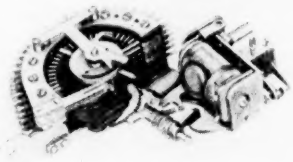
OXYGEN CYLINDER VALVE

New OV600 Oxygen Cylinder Valve for airborne gaseous oxygen bottles is positive acting and slow opening, has "O" rings for the spindle seal, spindle of stainless steel, and seating on a Kel-F plastic seat, thus providing positive no-leak shut-off. A pressure gage indicates pressure in the oxygen bottle.—*Robbins Aviation, Inc., 2350 East 38th St., Los Angeles 58, Calif.*



For more information circle **207** on inquiry card.

VARISTOR SPARK SUPPRESSOR IN SWITCHES

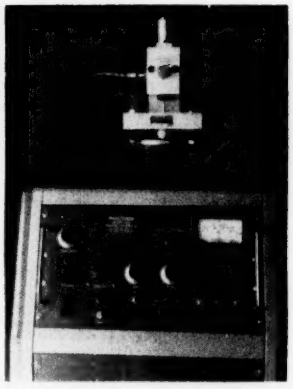


Varistors in silicon-carbide rotary stepping switches and relays are said to suppress arcs more effectively and reduce radio interference appreciably. —*Automatic Electric Co., Industrial Products Div., Northlake, Ill.*

For more information circle **208** on inquiry card.

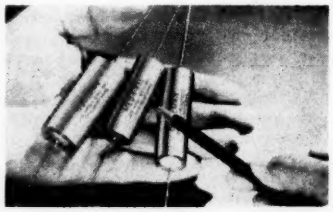
PNEUMATIC FUNCTION GENERATOR

New Functionair Model 100A Pneumatic Function Generator provides a pneumatic signal source for dynamic testing of pneumatic components and systems. The unit converts electrical signals into pneumatic pressure signals and responds to frequencies from 0 to 50 cps when used with volumetric loads up to 20 cu in. Static accuracy is 1% of full scale.—2-page bulletin gives details.—Power requirements are 117 vac, 60 cps, 900 watts.—*Palisades Engineering Co., Inc., P.O. Box 22, Pacific Palisades, Calif.*



For more information circle **209** on inquiry card.

MINIATURE CAPACITORS



New Miniature High Reliability Capacitors, Mega-Rel MR 463 Series, are the smallest physical sizes available in high reliability capacitors.—Catalog MR 463-1 includes comparison chart with sizes listed in MIL-C-26244 (USAF) and MIL C-25A.—*The Gudeman Co., 340 W. Huron St., Chicago 10, Ill.*

For more information circle **210** on inquiry card.

EPLAB

Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

*Vandaveer, Industrial & Engineering Chemistry, Vol. 22, page 596, June 1930.

BULLETIN No. 3 ON REQUEST—Address: 2 Sheffield Ave., Newport, R. I.

THE EPPLEY LABORATORY, INC.

SCIENTIFIC INSTRUMENTS

NEWPORT, RHODE ISLAND, U. S. A.

For more information circle **81** on inquiry card.

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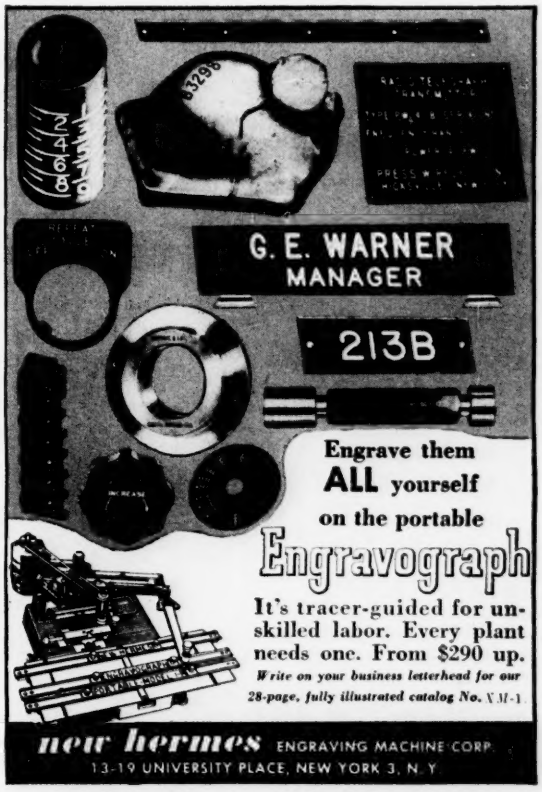
For more information circle **82** on inquiry card.



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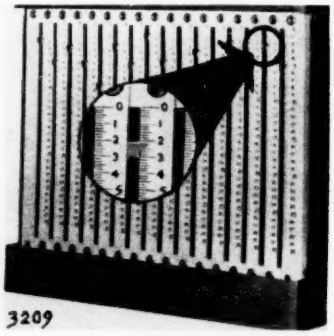
For more information circle **83** on inquiry card.

16-INTERVALS TIMER

New Model 51 Timer controls up to 16 sequential time intervals which are easily adjusted independently.



Maximum is 30 min for each interval shown on easily-read scale, calibrated in 10-sec increments.—*Bald Eagle Corp., 356 Cedar St., St. Paul 1, Minn.*

For more information circle **211** on inquiry card.

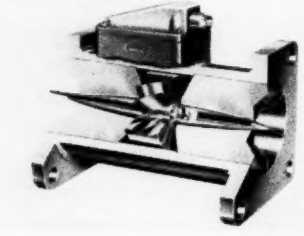
TAPE SYSTEM

New Analog-Punched Tape Data System, Model ZA-750, for handling quasi-static data produces an 8-level punched-tape output from a 20-channel, quasi-static d-c input. Program formats can be changed easily and quickly by a plug-patchboard.—4-page bulletin gives details.—*Electronic Engineering Co. of Calif., 1601 East Chestnut Ave., Santa Ana, Calif.*

For more information circle **212** on inquiry card.

IMPELLER FLOWMETER

New rate or totalizing flowmetering system features low pressure drop (less than 2.5 psi) and transmitter accuracies of ±1% over ranges from 3 to 600 gpm. Impeller transmitters

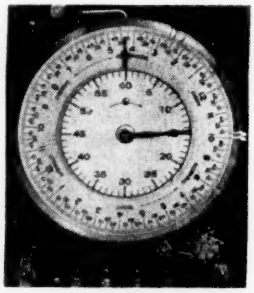


made of stainless steel or aluminum alloy with temperature range from −350°F to +300°F produce a gated 400-cps output of 2.5 v regardless of flow rate; cancel out effects of stray electrical fields and produce a very large signal-to-noise ratio. Transmitter output is fed directly to recorders or indicators, with no intermediate amplification required.—*Revere Corp. of America, Wallingford, Conn.*

For more information circle **213** on inquiry card.

PROGRAM INSTRUMENT

New 2200 series Paragon Program Instrument is an automatic switch which can be set to close an electrical circuit at any desired 5-minute in-



tervals of a 24 hour period. The circuit closure can be from 2 to 60 seconds and occurs precisely at the times selected. As many as 288 operations in a 24-hour period are possible.—*Paragon Electric Co., Two Rivers, Wis.*

For more information circle **214** on inquiry card.

HOT PLATE AND STIRRER

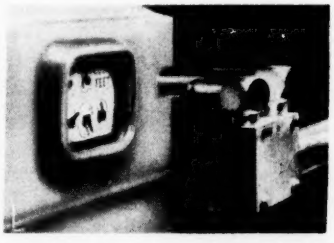
New Model H Combination Hot Plate and Magnetic Stirrer has stainless steel case which remains cool at all times despite unit providing 750

watt maximum output with three heat positions. Variable stirring is supplied with Teflon stirring bars.—*E. H. Sargent & Co., Dept. HP, 4647 W. Foster Ave., Chicago 30, Ill.*

For more information circle **215** on inquiry card.

DIAL ROTATION MONITOR

New miniature unit for dial rotation detection, originally developed for gas-meter accuracy tests is suited



for weight control on the production line because the pointer (pre-adjusted) does not pass a specific predetermined point.—*Ess Instrument Co., Bergenfield, N. J.*

For more information circle **216** on inquiry card.

FLEXIBLE COUPLINGS

New miniature flexible couplings have no back-lash and transmit uniform angular velocity at high speeds

through seamless metal bellows. Shaft sizes range from 1/8" to 1/2". Overall lengths vary from 37/64" to 1-3/32".—*Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., Milford, Conn.*

For more information circle **217** on inquiry card.

HALL-EFFECT DEVICES

New Halltron Type HS-51, a semiconductor device (indium-antimonide) utilizing the Hall effect, is now available from stock. A typical example of its performance is as follows: for inputs of 500 milliamps control current and 10 kilogauss magnetic field,

the output voltage exceeds 500 millivolts. At zero field, the input impedance is 0.8 ohms, and at 10 kilogauss, the output impedance is 2.5 ohms. Frequency response is in the order of 10^{-10} to 12^{-12} sec.—*Ohio Semiconductors, Inc., 1035 W. Third Ave., Columbus 8, Ohio*

For more information circle **218** on inquiry card.

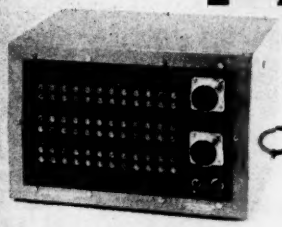
PUSH BUTTONS

New Bulletin-2901 single-element Push Buttons, engineered for standard-duty general-purpose a-c and d-c

control circuits, contains momentary double-break silver-to-silver contacts rated at 3 amps, 120 vac.—*Ward Leonard Electric Co., 150 McQuesten Parkway South, Mount Vernon, N. Y.*

For more information circle **219** on inquiry card.

PACE



THERMOCOUPLE REFERENCE JUNCTION

NEW BRJ SERIES UTILIZES MAGNETIC AMPLIFIER CONTROL FOR EXTREME PRECISION —

1/5°F STABILITY

- REFERENCE TEMPERATURES from 25° F above ambient to 250° F — *Special models for reference temperatures below ambient.*
- CHANNEL CAPACITY up to 48 channels in standard 110 volt rack or cabinet models.
- MULTI-WIRE junctions for thermocouple choice in each channel.
- THERMOCOUPLE TABLES for 150° F reference available. Write for your copy.

PACE *engineering company*

6913 Brik Avenue North Hollywood California • Phone POplar 5-0453

For more information circle **84** on inquiry card.

GREEN *Pantograph Engravers*

ELIMINATE DELAYS!

Keep the work in your own plant.

PORTABLE 40-POUND BENCH-MODEL 106

Famous 2 or 3-dimensional engraver, successfully used by thousands, features 5 positive, accurate pantograph ratios. Versatile ball bearing spindle has three speeds up to 14,000 rpm; height of pantograph and position of cutter are continuously adjustable; one copy carrier (supplied) accepts all standard master type sizes.

The Model 106 has proven incomparable for speed and accuracy . . . yet reasonably priced.

Cutter grinders, rotary tables, master letters, compound slides, name plates and all required accessories. For complete information, write to

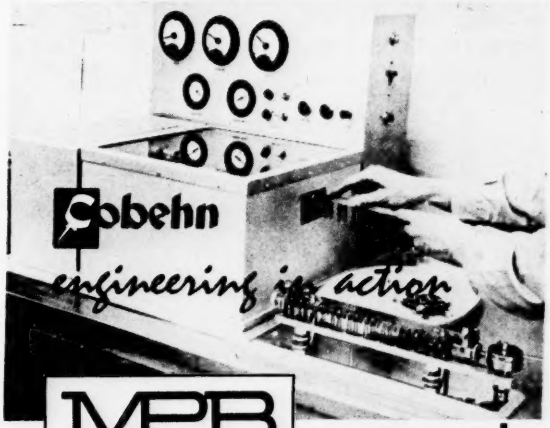
MODEL D2 HEAVY DUTY 2-DIMENSIONAL

GREEN INSTRUMENT COMPANY, INC.

383 PUTNAM AVENUE, CAMBRIDGE 39, MASS.

For more information circle **85** on inquiry card.

TO UPGRADE PRODUCTION . . .

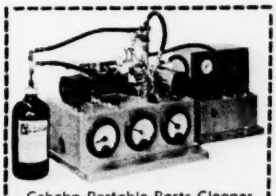


automated bearing cleaning

One-at-a-time final cleaning of instrument bearings to rigid quality-control specifications slowed production at Miniature Precision Bearings, Inc., Keene, N.H. Bearing contaminants were removed with manually-operated spray equipment. To upgrade production, MPB, Inc., specified the Cobehn automatic parts cleaner. The model installed (illustrated above) thoroughly cleans 2400 precision instrument bearings an hour at an approximate cost of three mils per bearing.

Cobehn precision parts cleaners are engineered for use on assembly lines where large numbers of semi-conductors, gear-clusters, bearings and other small electronic and electro-mechanical components are cleaned on a continuous production schedule. Oil, grease, silicone lubricants, rosin flux and other foreign matter are safely and economically removed in seconds.

The Cobehn cleaning method provides:



Cobehn Portable Parts Cleaner Model No. 1-2BC-2S-2

- **a) Uniformity in cleaning technique;**
- **b) Close control over solvent costs;**
- **c) Controlled rotation of parts during cleaning;**
- **d) Elimination of chilling and condensation;**
- **e) Chemically cleaned parts without film, residue or corrosive effect. (Fractionally distilled Cobehn solvent far exceeds Fed. Specification P-S-661 b);**
- **f) Integral ventilation system.**

For specific information about your critical cleaning problems, send product information and production requirements. Our engineering report will be forwarded without delay.

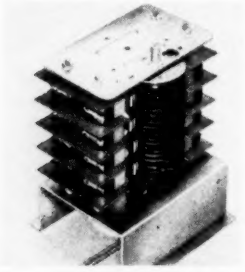
Cobehn® Inc.

Passaic Avenue
Caldwell, New Jersey

For more information circle **86** on inquiry card.

PROGRAM TIMERS

New Type 511 and Type 521 field-adjustable Cycling Timers have up to 8 independent timed intervals. Cycle times available are from 6 seconds to

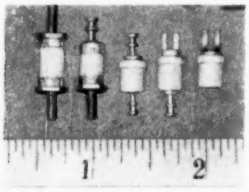


48 hours. Type 511 provides from 1 to 3 load switches, Type 521 from 4 to 8. Load switches are rated for 20 amps at 125 or 250 vac, the motor for 115/230 v, 25, 50 and 60 cps.—*Cramer Controls Corp., Centerbrook, Conn.*

For more information circle **220** on inquiry card.

TEFLON STANDOFF TERMINALS

New Teflon insulated Standoff Terminals 2415, 2417, and the X2182 series press fit into a 0.205" ±0.002" hole, their sizes varying to accommodate panel thicknesses from $\frac{1}{16}$" to



$\frac{1}{8}$". Others are the #2167 and the #2168, available in two sizes, with standing heights, when mounted, of $\frac{1}{2}$" or $\frac{3}{4}$"; and the #2168, which has a brass mounting stud.—*Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.*

For more information circle **221** on inquiry card.

ELECTRIC COUNTER

New six-digit CE-800 features two hundred million count life, complete dustproof enclosure; built-in silicone diode full-wave bridge rectifier with capacitor for maximum reliability and service life through all ac voltages to 230 with 25-, 40- and 60-cps frequencies; also dc; protection against tampering; 1000 counts per minute (operates reliably at much higher speeds with electronic actuation); knob or key reset.—*Production Instruments Div., General Controls Co., 8062B McCormick Blvd., Skokie, Ill.*

For more information circle **222** on inquiry card.

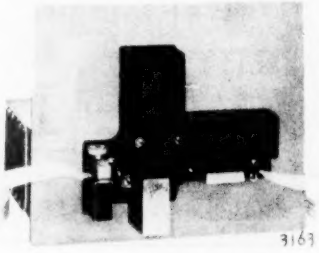
SUBMINIATURE RELAY

New high-precision Type S-M, for control systems, computers, aircraft, missiles, etc., is less than 1" long and weighs less than ½ oz; is designed for continuous use in −65°C to 125°C range; is said to have a life expectancy of over 100,000 operations at rated load. Nominal coil voltage 26.5 vdc; contact arrangement 2p-dt; contact rating 2 amp @ 28 vdc resistive; max contact bounce 1 ms; operating shock 50 *G* for 11 ms; vibration 20 *G* @ 5 to 2000 cps.—*Comar Electric Co., 3349 W. Addison St., Chicago 18, Ill.*

For more information circle **223** on inquiry card.

TAPE STRIP READER

New completely transistorized 909, for processing information on perforated tape strips into digital data

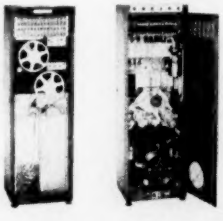


computer systems, requires virtually no training for operation by clerical personnel. Although built to MIL-E-4158A, it is said to be priced lower "than less advanced contemporary equipment manufactured to commercial specs." Among features: character reading speeds up to 1000 char/sec; simple in-line threading; stops on STOP character (0.2 millisec) and will read next character after start; photo diode head reads any tape (including oiled yellow teletype tape); reads 5, 6, 7 or 8 level tape with sprocket channel.—*Potter Instrument Co., Sunnyside Blvd., Plainview, N. Y.*

For more information circle **224** on inquiry card.

TAPE TRANSPORT SYSTEM

New Model 424 fully-transistorized Tape Transport is new-type system to record, store, and reproduce analog or digital data. Two independent capstan drives, with high-speed start-

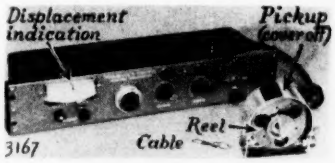


stop times of less than 2 millisec, permit tape to operate in either direction at speeds from 7½ ips to 60 ips (150-ips high-speed model also available). Tape widths from ¼" to 2" can be handled.—*D. G. C. Hare Co., 30 Burtis Ave., New Canaan, Conn.*

For more information circle **225** on inquiry card.

DISPLACEMENT SYSTEM

New combination of Model 4040-10 "automatic measuring tape" and Model 4040-C Control measures dis-



placements under dynamic load tests, even at elevated temperature. Pickup produces a signal directly proportional to cable extension; has 10-ft range; is capable of following sinoidal displacements of 5-ft amplitude at frequencies up to ½ cps. Indicator-transmitter using a bridge null detector provides visual indication, voltage output, zero-displacement setting, max and min displacement limit switches, limit indicator lamps, and means for instrument calibration.—*Research, Inc., Hopkins, Minn.*

For more information circle **226** on inquiry card.

SMOOTHNESS-POROSITY-SOFTNESS TESTER

New version of maker's S-P-S Tester (also known as Gurley-Hill Tester) is available with an automatic timing attachment and electric stop timer: no more need to use stopwatch.—*W. & L. E. Gurley, Troy, N. Y.*

For more information circle **227** on inquiry card.

TORQUE-FREE BEARING

New Model D-3 Dynamic Bearing is an electro-magnetically-powered ball-bearing assembly for applica-

tions requiring virtually torque-free performance. An electromagnetic device oscillates outer ring of supporting bearings to cancel out friction torque.—*The Barden Corp., Danbury, Conn.*

For more information circle **228** on inquiry card.

SHOCK-PROOF . . . VIBRATION-PROOF BROOKS MAG/NA/LARM*

instantaneous signalling of high or low flow

Used with Brooks Full-View* and Ar-Met* rotameters, the Mag/Na/Larm is readily adaptable to a variety of flow alarm and simple control functions.

The unit operates directly from a magnetic metering float extension . . . has four individually adjustable alarm points that can be set anywhere along the range.

Engineered for the utmost reliability, the Mag/Na/Larm incorporates fail-safe relay circuits and hermetically-sealed magnetic switches.

Mag/Na/Larm has been designed for use with interchangeable metering elements. That's why when you buy Brooks, you buy for today's needs . . . and tomorrow's possibilities.

Write for Bulletin 165

*Trademarks

BROOKS ROTAMETER COMPANY
1158-I STREET,
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For more information circle **87** on inquiry card.

OPTICS

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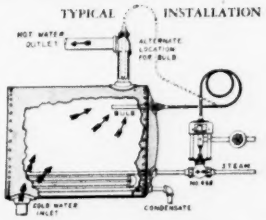
ARSENIC TRISULPHIDE
BARIUM TITANATE
BISMUTH
BRASS
CARBORUNDUM
CERAMIC
COPPER
*CORNING 707
*CORNING 7052
FERRITE
FERROX
**FLUORIDE, CALCIUM
**FLUORIDE, LITHIUM
GERMANIUM
INDIUM ANTIMONITE
INDOX
MELAMINE FIBER GLASS
MICA, SYNTHETIC
POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
**SODIUM CHLORIDE
**STEEL
STRONTIUM TITANATE
TITANIUM DIOXIDE
*VYCOR
*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

*Carried in stock
**Purchased for orders

For more information circle **88** on inquiry card.

If you need to control tank temperature



call for a valve from Klipfel

Klipfel Temperature Regulator Valves operate without auxiliary power. Pressure changes in a temperature-sensitive bulb are transmitted to a seamless, 2-ply, extra-strong bellows which opens or closes the valve smoothly to maintain desired temperature.

Wide Temperature Range **Indestructible Yoke**
Direct or reverse action **Manual override**
Single, double or three-way bodies

Call your supply house or write for Bulletin 354-A.

No. K-449 Temperature Regulator Valve

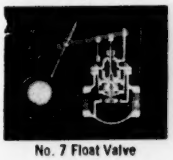
No. K-348 Temperature Regulator Valve

AIR MAIL
Most items shipped within 24 hours after order is received

No. 410 Reducing Valve

No. 300 Reducing Valve

No. 135 Relief Valve


No. 7 Float Valve

No. 27 Float Valve

No. 135 Multiport Relief Valve

HAMILTON • OHIO **Klipfel** VALVES INC.

Automatic Temperature-and-Pressure-Regulating Valves Since 1902

Float Valves • Temperature Regulators • Back Pressure Valves • Reducing Valves

A DIVISION OF THE HAMILTON-THOMAS CORPORATION

For more information circle **89** on inquiry card.

Dynisco

Miniature

PRESSURE TRANSDUCER

Incorporates
Unbonded Strain Gauge

HIGHLIGHTS

► EXTREMELY SMALL FLUSH-MOUNTED PRESSURE DIAPHRAGM

► HIGH NATURAL FREQUENCY

► ½ % ACCURACY

► STANDARD UNITS GUARANTEED AND TESTED TO +300°F

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PRESSURE RANGES

PT 31 0-300 to 0-5,000 PSI
MOUNTS IN 5/16-24 THREADED HOLE
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PT 32 0-6,000 to 0-15,000 PSI
MOUNTS IN 3/8-24 THREADED HOLE
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For more information on Dynisco pressure, force, flow, and displacement pickups, write:

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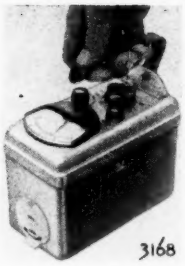
Cambridge 42, Mass.
UN 4-7280

For more information circle **95** on inquiry card.

GAMMA-BETA SURVEY METER



New Model GB-1 is an improved type of portable gamma-beta log-linear radiation survey meter featuring fast response time, 0-1 mr-hr linear and two 3-decade ranges 0.5-500 mr/hr, 0.5-500 R/hr; mercury battery 300 hr continuous operation, one year intermittent; energy dependence flat to within 10% from 80 kv to 1.2 Mev. ★Model GB-3, same as model GB-2, but with one logarithmic range, 0.5 to 500 mr/hr. —*Riggs Nucleonics Corp.*, 717 *N. Victory Blvd., Burbank, Calif.*

For more information circle **229** on inquiry card.

LOW-TEMPERATURE PROBE

New Model 134, with temperature range from −200°C or lower to 250° C or higher, is suitable for LOX

(liquid oxygen) and its usefulness down to liquid helium range is expected. Temperature range −200°C (−328°F) or lower to 250°C (482°F) or higher. Primary element pure platinum wire with strain-free mounting and protected by ceramic coating. Standard resistance 1380 ohms at 0°C (lower and slightly higher available). Characteristic time 0.1 sec in water @ 3 fps. Self-heating effect 2 watts per C° in water @ 3 ftps.—*Rosemount Engineering Co.*, 9424 *Lyndale Ave. So., Minneapolis*, 20, *Minn.*

For more information circle **230** on inquiry card.

TRANSISTORIZED RELAY

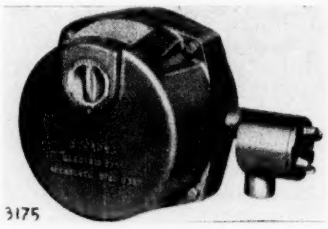
New supersensitive Model T-681 weighs 30 oz; is recommended for use with thermoregulators and other mi-

croampere-level units; controls a load up to 1500 watts. Features include convenience outlet for stirrer or auxiliary heater; internal n-o/n-c reversing switch.—*Precision Thermometer & Instrument Co.*, 1434 *Brandywine St., Philadelphia* 30, *Pa.*

For more information circle **231** on inquiry card.

DISC BRAKE

New Series UH50 is said to make available an ac brake with UL approval for both Class 1 Group D and



Class 2 Group E, F, and G, for mounting on NEMA C mounting flange of fhp motor frames 56-C and 66-C, integral hp motor frames 182 and 184. Available for 110 to 550 v, 25, 50, or 60 cps.—*Stearns Electric Corp.*, 120 *N. Broadway, Milwaukee, Wis.*

For more information circle **232** on inquiry card.

VOLTAGE REGULATOR

New 115-v portable high-power-output Model 605, added to Series 600 completely automatic voltage regulators, can absorb high overload surges while delivering undistorted 0.25% true rms voltage regulation. When operating within ± 10% correction range it delivers 12 kva with 100-amp output. Total correction time is only 4 sec. Performance is completely independent of load power factor.—*Tel-Instrument Electronics Corp., Dept. W*, 728 *Garden St., Carlstadt, N. J.*

For more information circle **233** on inquiry card.

PRESSURE STANDARD

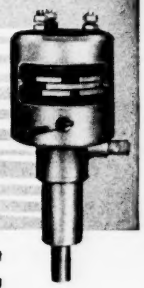
New portable electronic secondary-pressure standard, the Vibromanometer, employs direct conversion of input pressures to a digital FM signal. Visual or printed readout is adjustable for any desired measurement unit, such as psi, percent of full-

scale, millibars, etc. Incorporates a Vibrotron transducer which operates by means of a vibrating wire attached to a pressure-sensitive metal diaphragm. Pressure changes are reflected as frequency changes and an electrical output is fed directly to a processing unit. No complex electronics are required.—*BJ Electronics, Borg-Warner Corp.*, 3300 *Newport Blvd., Santa Ana, Calif.*

For more information circle **234** on inquiry card.

SPEED SENSITIVE SWITCHES

1, 2 and 3 ELEMENT



UNDERSPEED . . . One S. P. D. T. switch to trip at speeds as low as 400 RPM. Maximum operating speed 5,000 RPM.

OVERSPEED . . . One S. P. D. T. switch to trip at speeds between 500 and 6,000 RPM.

OVER AND UNDERSPEED . . . Two S. P. D. T. switches to trip at two different speeds between 500 and 6,000 RPM.

OVER—INTERMEDIATE AND UNDERSPEED . . . Three S. P. D. T. switches to trip at three different speeds between 1,200 and 6,000 RPM.

Speeds above or below those listed above must be referred to our Engineering Department for special consideration. Request Bulletin 504 describing our Speed Sensitive Switches.

SYNCHRO-START PRODUCTS, INC.
8151 N. RIDGEWAY AVE., SKOKIE, ILLINOIS
Automatic Engine Control Sets • Special Control Panels • Safety Alarm Sets • D. C. Solenoids • Heavy Duty Relays

For more information circle **96** on inquiry card.

Statement of Ownership, etc.

Statement required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946 (Title 39, United States Code, Section 233) showing the Ownership, Management, and Circulation of

INSTRUMENTS & AUTOMATION

published monthly at Pontiac, Illinois for October 1, 1958.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Richard Rimbach, 8550 Babcock Blvd., Pittsburgh 37, Pa.; Editor, Milton H. Aronson, 4800 Stanton Avenue, Pittsburgh, Pa., Managing editor, F. D. Marton, 209 Gilkeson Avenue, Pittsburgh, Pa.; Business manager Richard Rimbach, 8550 Babcock Blvd., Pittsburgh 37, Pa.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.)

Richard Rimbach, Sr., Pittsburgh, Pa.; Mrs. Richard Rimbach, Pittsburgh, Pa.; Richard Rimbach, Jr., Pgh., Pa. Mrs. M. F. Behar, Pittsburgh, Pa.; Milo Pugh, Altadena, Calif., Milton Aronson, Pgh., Pa., Martha Rimbach, Pgh., Pa., Gretchen Rimbach, Pgh., Pa.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

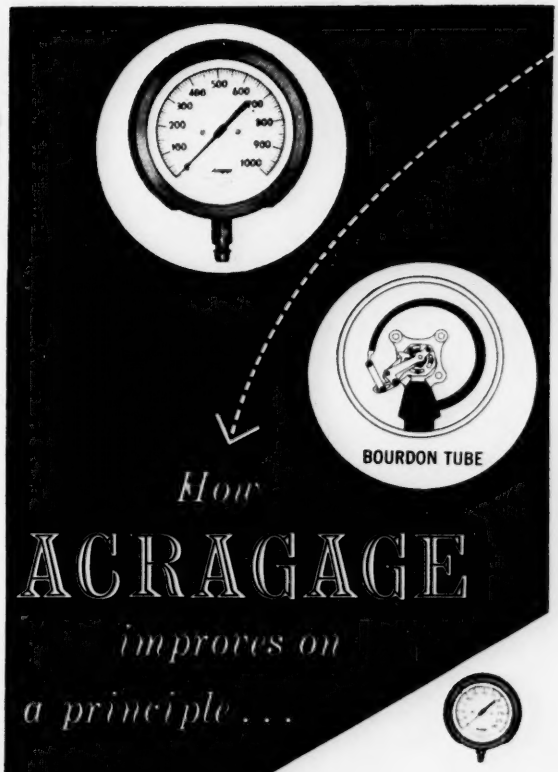
5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only).

Richard Rimbach, Publisher

Sworn to and subscribed before me this 1st day of October, 1958.

[SEAL] Kenneth M. Winterbottom,

(My commission expires Dec. 11, 1959)



How

ACRAGAGE

improves on a principle . . .

Acragage's reputation for high accuracy and dependability is a result of continuous research and development. The Bourdon Tube, ("heart" of Acragages) was patented over a hundred years ago. Acragage technicians, however, have always felt that if anything is good, research can make it better.

The result is a Bourdon Tube which is 10% to 15% longer than those in general use. Heavier walled tubing is used in its construction enabling the tube to operate well below its elastic limits. Sustained accuracy, increased repeatability, and greater over-pressure protection are provided with Acragage's longer Bourdon Tube. Acragage Bourdon Tubes are available in Phosphor Bronze, Alloy Steel, Stainless Steels, and Monel.

Improved Bourdon Tubes are only one of many features that have made Acragage the choice of technicians and engineers who demand the finest in gages. **Mail coupon for more information and catalog.**

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- Reduced cost
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- Corrosion resistance
- Dry operation
- Non-magnetic material

BIG REASONS WHY

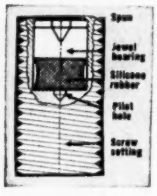
Bird PRECISION JEWEL BEARINGS MEAN BETTER INSTRUMENT PERFORMANCE

In today's miniaturized instrumentation Bird Sapphire and Glass Jewel Bearings show their unique properties to best advantage . . . dry operation through temperature extremes . . . resistance to corrosion fumes and liquids . . . adaptability to special mounting arrangements.

Bird Complete Jewel Assemblies

. . . save time and money, cut rejects, keep production flowing smoothly. Special mounting techniques provide assemblies in screws or bushings of any style.

Bird Cushion Jewel Assemblies



. . . add shock protection to any instrument for only pennies. Variable cushioning of silicone rubber controls movement, eliminates waste due to poor bearing adjustment in mounting.

Compared with other types of bearings Bird Jewels are substantially more economical and their long life expectancy eliminates maintenance problems.

NEW CATALOG AVAILABLE

. . . a complete description of properties and uses of jewel bearings for aircraft, electrical and timing instruments, recorders and indicators. Write for your copy.

Richard H. Bird & CO., INC.
1 Spruce Street, Waltham, Mass.
Serving Industry With Fine Jewels Since 1913

For more information circle **98** on inquiry card.

MOTOR GOVERNOR

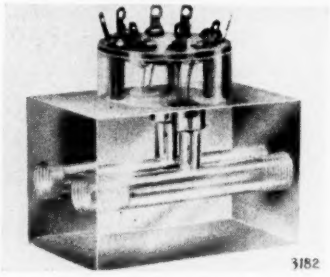
New governor body mounts directly on standard SAE tachometer take-off (no need for flexible drive ca-

ble); is available for company's complete line of overspeed, underspeed, 2-switch and 3-switch governors. Unit shown is essentially a single-element speed-sensitive switch, either manual or automatic reset.—*Synchro-Start Products, Inc.*, 8151 *N. Ridgeway Ave., Skokie, Ill.*

For more information circle **235** on inquiry card.

GAS CHROMATOGRAPHY CELLS

New gas chromatography cells use tiny VECO thermistors enabling fast response, accurate and sensitive ther-



mal conductivity detection and analysis. Small cell block houses a matched pair of thermistor elements, one for gas under test, one for reference gas flow. A bridge network is built into each cell.—*Victory Engineering Corp.*, 533 *Springfield Rd., Union, N. J.*

For more information circle **236** on inquiry card.

DIAL INDICATOR

New Super Compar-it Gaging Head features constant measuring pressure, practically frictionless move-

ment, and 10-microinch accuracy.—*George Scherr Co.*, 200 *Lafayette St., New York* 12, *N. Y.*

For more information circle **237** on inquiry card.

THERMOCOUPLES AND CONDUCTORS

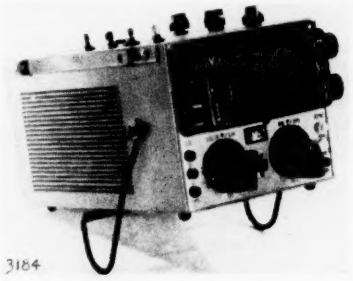
New metal-clad, ceramic-insulated thermocouples and conductors feature heavy sheath wall, perfect centering

and roundness of wires, and dense-pack insulation.—8-page Catalog PN10 contains details.—*Pyro-Electric, Inc., P.O. Box* 232, *Barrington, Ill.*

For more information circle **238** on inquiry card.

PORTABLE OSCILLOSCOPE

New direct-reading Pocketscope Hi-Gain Model S-17-A with radically new innovations is said to be "com-



parable to a shoebox in size and a large laboratory oscilloscope in performance." Direct-reading feature allows direct calibration of scales in volts (from 10 mv/div) and milliseconds (from 10 usec/div). Sync signal >1 v peak automatically triggers 'scope. Sync light indicates presence or absence of proper level.—*Waterman Products Co., Inc.*, 2445 *Emerald St., Philadelphia* 25, *Pa.*

For more information circle **239** on inquiry card.

HUMIDITY INSTRUMENTS

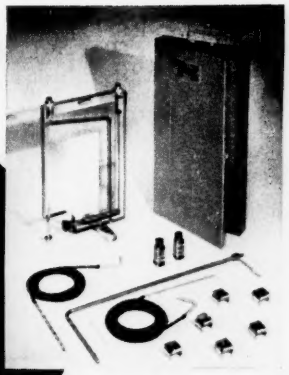
Two new recorders: (1) Hygrograph records percent of relative humidity directly. A low-friction linkage converts nonlinear expansion of a precise hygroscopic hair element into linear pen motion on chart uniformly graduated 0 to 100%. (2) Two-pen Thermo Hygrograph records both RH and temperature; incorporates mercury-actuated system with a range from 0 to 100°F.—*Dept. HTH, Weksler Instruments Corp., Freeport, L. I., N. Y.*

For more information circle **240** on inquiry card.

Dwyer
CONTROLS GAGES

AIR VELOCITY METER No. 400

One Instrument Tells Both Air Velocity and Static Pressure!



- Reads directly in feet per minute and inches of water.
- Check *all* velocities from 400 to 10,000 F.P.M.
- All static pressures from 0 to 10" of water.

Tests fan and blower discharge and inlet pressures, pressure drop across filters, balances air conditioning systems, etc. Complete kit includes dual purpose manometer, 18" stainless steel pitot tube, Magneclips and all necessary fittings, tubings, instructions and accessories.

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For more information circle **99** on inquiry card.

Automatic Control Technology, Modern Theory and their Usefulness

483 + XV pages; 1957, 898 illustrations and 48 tables. Includes 90 advanced papers on control technology, as delivered in original language (English, French, German, Russian; all Russian papers are translated into German; about ½ of book is in English). 9" x 12". Handsome cloth binding. Printed by R. Oldenbourg Verlag, Munich, Germany.

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". . . a practical text . . . covers fundamentals, basic bridge circuits, typical applications, and surveys typical commercial instruments which use or are used with strain gages."

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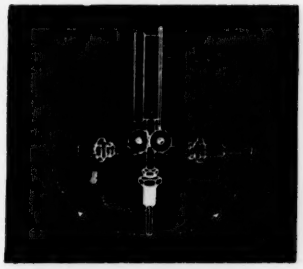

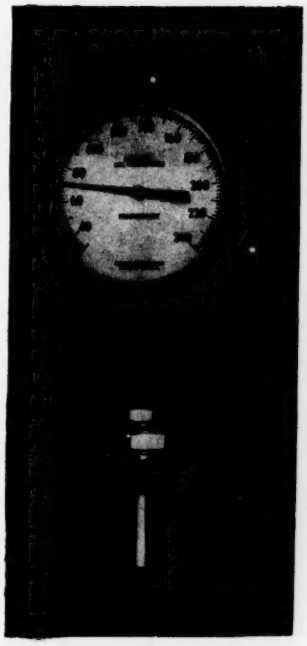

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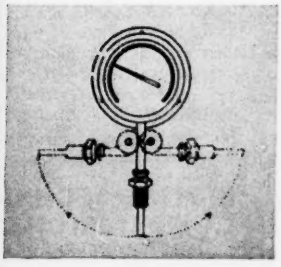

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Up or down—left or right, you can easily install Moeller adjustable form dial indicating thermometers at any advantageous reading angle.

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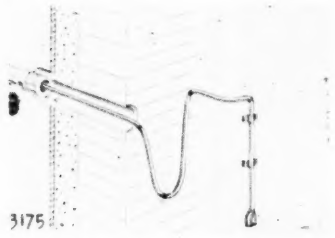
For more information circle **100** on inquiry card.

NEW INSTRUMENTS

FURNACE-TUBE-WALL TCs

New thermocouples for furnace tube walls reduce installation time up to 75%. They measure increase

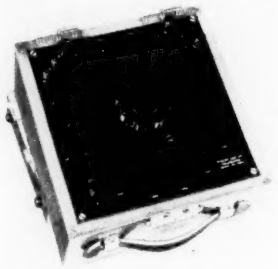


in outer wall temperature when heat transmission is reduced by coking or scaling of inner wall. Installation time saving was made possible by use of Ceramo construction—ceramic-insulated conductors encased in over-all metal sheathing. Among advantages over rigid bulky assemblies: can be bent to almost any shape; no more need of large holes in furnace wall; no hot spots resulting from faulty insulation around large rigid assemblies; completely-enclosed measuring junctions need only be tack-welded to tube wall; extremely small ODs from $\frac{1}{16}$" to $\frac{1}{8}$".—*Thermo Electric Co., Inc., Saddle Brook, N. J.*

For more information circle **241** on inquiry card.

TEST RESISTANCE NETWORKS

New synchro and resolver Test Resistance Networks determine electrical error by the proportional-voltage method. Accuracy is claimed to be four parts in 100,000. Both test net-



works are available with steps of $2\frac{1}{2}°$, 5°, or 15°. Voltage dividers—three in the synchro, four in the resolver—permit full 360° rotation to be checked without changing connections.—*Rubicon Instruments Div., Minneapolis-Honeywell Regulator Co., Ridge Ave. at 35th St., Phila. 32, Pa.*

For more information circle **242** on inquiry card.

HIGH-TEMPERATURE TC

New Cerami-Kouple metal-sheathed ceramic-insulated thermocouple wire combines high electrical sensitivity with small size; withstands high temperatures and corrosive atmospheres; bends on a radius as small as its own diameter without collapsing metal sheath or shorting wires; provides the quick thermal response necessary

for automatic control. Insulation is magnesium oxide or aluminum oxide. Sheath materials for various requirements. Now being produced in continuous lengths in excess of 100 ft. Nominal ODs 1/25" to $\frac{3}{8}$".—*E. C. Smith Mfg. Co., Conshohocken, Pa.*

For more information circle **243** on inquiry card.

FUNCTION GENERATOR

New • MC-670 Card-Programmed Diode Function Generator employs conventional diode-breakpoint circuitry, but set-up is accomplished by inserting a punched paper card into the front of the function generator and closing an actuating door over the card, thus greatly reducing computer and data handling operating costs. Generator employs plug-in circuit boards of gold-plated epoxy glass. Repeatability is ±0.02%; accuracy is ±0.1%.—*Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N. Y.*

For more information circle **244** on inquiry card.

DIGITAL TECHNIQUES FOR COMPUTATION AND CONTROL

by Martin L. Klein, Harry C. Morgan, Milton H. Aronson . . . FIRST comprehensive survey of basic digital techniques . . . includes basic principles, basic circuits, components and available commercial equipments . . . Dynamic digital material thoroughly covered in 394 pages. Cloth bound with dust jacket, illustrated. 5½" x 8½" **$6.00**

PRINTED CIRCUITRY

by Allan Lytel. A valuable working tool: includes alternative and recommended practice for each step in design and production of printed circuits; a buyer's guide to special components; and "how to" service data. Paperbound, illustrated. 192 pages. 1957 ..... **$2.00**

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edited by M. H. Aronson. A clear introduction to the entire field of electronic computers and data processors. Presentations by computer manufacturers at the Second Computer Clinic. Paperbound. 72 pages. 1956 ..... **$2.00**

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Make a G-M PORTABLE D'ARSONVAL
GALVANOMETER
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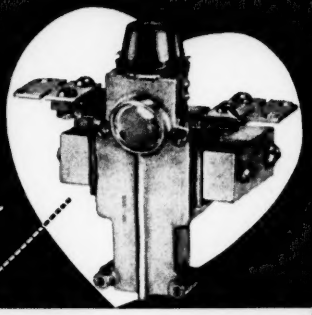

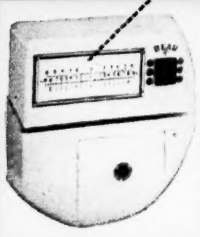

IN THE AUTOMOTIVE FIELD, the Bear Manufacturing Co. of Rock Island, Ill. uses Series 500 G-M Galvanometers in its new remote-reading Electric Wheel Alignment System (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

G-M LABORATORIES • INC.
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For more information circle **102** on inquiry card.

MAGNETIC CLUTCHES

New Type DZ Precision Magnetic Clutches are made as single and double ended units for 24-28 vdc in Mark-8 or Size-18 frame and measure

$1\frac{3}{4}$" dia with $\frac{1}{4}$" shaft dia. Power consumption is 3 watts, output torque is 16 in oz min.—*PIC Design Corp., Sub. of Benrus Watch Co., Inc., 477 Atlantic Ave., East Rockaway, L. I., N. Y.*

For more information circle **245** on inquiry card.

POWER RECTIFIERS

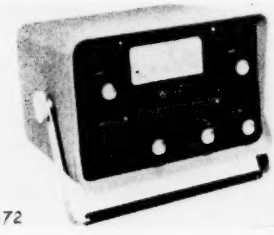
New NL line of low-cost, general purpose axial lead types provide efficient operation in ambient tempera-

tures up to 100°C. Output current rating is 500 milliamps at 100°C with PIV's from 50 to 500 volts.—*North American Electronics Inc., 212 Broad St., Lynn, Mass.*

For more information circle **246** on inquiry card.

AC/DC VOLT-OHMMETER

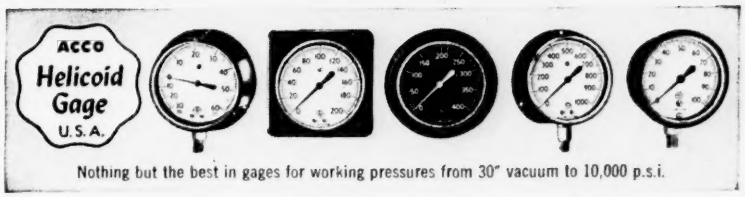
New Model R-2 Voltmeter has exceptional versatility for a single portable instrument. It measures alter-



3172

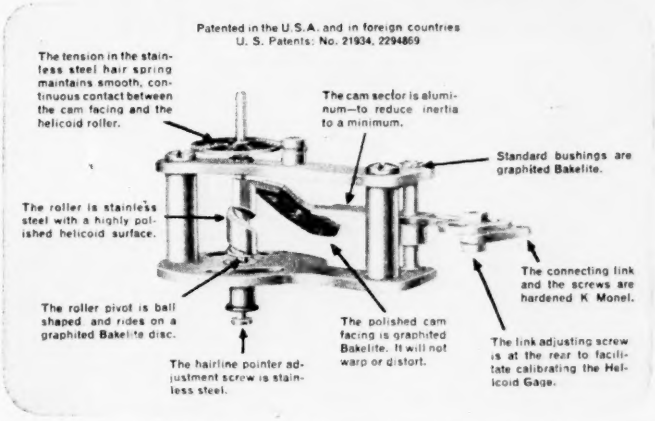
nating voltages from 1 mv to 1000 v full-scale, positive and negative direct voltages from 1 v to 1000 v full-scale, and half-scale resistance readings from 10 ohms to 10 megohms at an over-all 3% accuracy on all readings. It also has an electrometer input for measuring 0-1 v dc at an impedance greater than 10,000 megohms. Battery-powered transistor circuitry eliminates warm-up time, and confers immunity to power-line transients which could damage transistors or cause erroneous readings.—*Southwestern Industrial Electronics Co., 2831 Post Oak Rd., Houston 19, Texas.*

For more information circle **247** on inquiry card.



Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

The Chemical Gage

The Helicoid Chemical Gage has a guaranteed accuracy of plus or minus 1%. It is applicable for working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. It is particularly suitable for chemicals and other viscous fluids which might clog or corrode a Bourdon tube. Pressure and or vacuum is transmitted directly to the indicating gage element through deflection of a Teflon or Kel F sealing diaphragm.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

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For more information circle **103** on inquiry card.

"Our engineers get more done, thanks to the Bendix G-15 computer"

says J. H. MITCHELL, *vice-president*
LOCKWOOD, KESSLER & BARTLETT • SYOSSET, NEW YORK

"As a civil engineering firm with a part in many major construction projects we have a heavy load of design computations. Before we acquired a Bendix G-15, our engineers had to do this tedious work themselves as part of each highway or structural design problem. Now the computer does these mathematical chores, and the engineers can use their time for more creative work. The G-15 enables us to give our clients optimum designs in the shortest possible time."

THE G-15 PROVIDES • Low-cost versatility for thousands of office and laboratory applications • Simplified operating methods • Memory and speed of computers costing four times as much • Typewriter input-output, paper tape output and 250 char/sec paper tape input at no added cost • Expandability through accessories for 1,200,000 words of magnetic tape storage and punched card input-output • Extensive program library • Users share programs Proven reliability • Nationwide service • Lease or purchase.

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Built and backed by Bendix, the G-15 is serving scores of progressive businesses large and small throughout the world. For details, write to Bendix Computer, Department J-5 Los Angeles 45, California.

For more information circle **104** on inquiry card.

NEW INSTRUMENTS

COMPOSITION RESISTORS

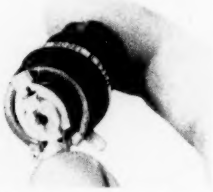
New fixed composition resistors, the ½-watt GBT-½, and the 1-watt GBT-1 with baked-on distinct color

bands to resist solvents are designed for use in standard automation equipment.—*International Resistance Co.*, 401 *North Broad St., Phila. 8, Pa.*

For more information circle **248** on inquiry card.

MINIATURE RHEOSTAT

New ceramic-and-metal Model E Rheostat, smaller than many 1 or 2-watt film or composition potentiometers, is capable of 12½ watts dissipa-

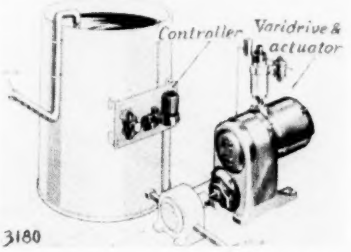


tion at 40°C. ⅞" in dia and extending ⅛" behind the mounting panel this miniaturized version has ceramic hub, independent contact arm pressure, vitreous enamel coating and other Ohmite features.—2-page Bulletin 157 contains complete information.—*Ohmite Mfg. Co.*, 3698 *Howard St., Skokie, Ill.*

For more information circle **249** on inquiry card.

LEVEL CONTROL SYSTEM

New liquid level control system for food or chemical processing industries tanks comprises a U. S. Level

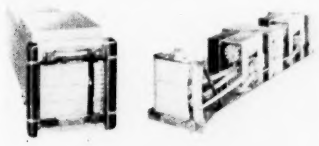


Controller, and a Varidrive Motor equipped with a pneumatic Varitrol actuator; is entirely pneumatic; contains no floats or flow-restricting valves. System provides two methods for level control in an open tank: Air Purge method, using bubbler tube, for water and other uniform liquids of low viscosity; Liquid Purge method, using a trickle flow of purge liquid, for higher viscosity liquids.—*U. S. Electrical Motors, Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.*

For more information circle **250** on inquiry card.

MINIATURE RECORDER

New all-electronic, two-pen strip-chart recorder has sensitivity of 0.1% or better, and accuracy to ±½% of full scale. Recorder fits a 5-inch



square panel cutout and can be furnished as an optional feature with a control set point, or alarm contacts, or both, for one of the variables.—*Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.*

For more information circle **251** on inquiry card.

MINIATURE RESISTORS

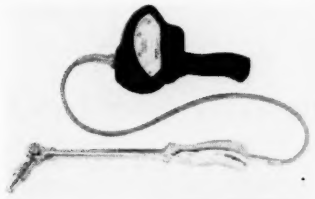
New Model 9855 Vamistor precision metal film resistor, specially designed for use in transistor circuits, aircraft and missile gear, computers, etc., is rated at ¼ watt at 125° C (derated to 0 at 190° C). Length is 0.650", diameter 0.235". Resistors are available

in values from 250 ohms through 500 K at tolerances of 0.25%, 0.5% and 1%. Standard maximum temperature coefficient of these thermally fused resistors is ±50 ppm/°C, with excellent high-frequency characteristics and absolute stability at low temperatures in shock or under vibration.—*Weston Instruments Div. of Daystrom Inc., 614 Frelinghuysen Ave., Newark 12, N. J.*

For more information circle **252** on inquiry card.

PORTABLE PYROMETER

New Model B Portable Hand Pyrometer for measuring temperatures of convex, rotating or flat surfaces; for plastics, rubber or semi-fluids,

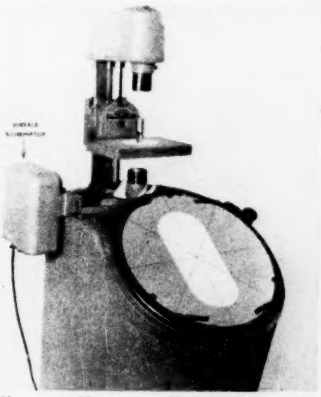


liquids, gases or molten soft metals; requires no power source, special tools or operator skill. The pyrometer is offered in 12 scale ranges which are automatically compensated for changes in ambient temperature.—*West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.*

For more information circle **253** on inquiry card.

SURFACE ILLUMINATOR

New Surface Illuminator which can be used on maker's Micro-Projector for all standard magnifications from

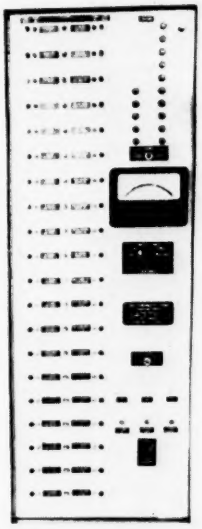


10X to 100X uses a 500-watt standard projection bulb to project contours which are on an opaque background. Colors are faithfully reproduced on the image.—6-page bulletin contains details.—*George Scherr Co., 200 Lafayette St., New York, N. Y.*

For more information circle **254** on inquiry card.

TEMPERATURE SCANNER

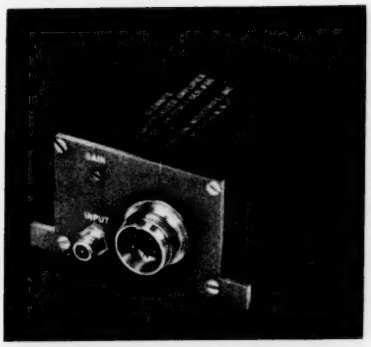
New digital variable indicator and temperature monitoring system scans a large number of thermocouples at a rate of five/sec and records when any exceed preset common off-normal



and/or alarm set point. If the alarm setting is exceeded, the system shuts down the plant. Thermocouple inputs can be programmed through an analog-digital system and be viewed on digital display panel. The scanner can characterize sweep voltage so that it exactly matches the emf curve of the type of thermocouples being sampled.—*Kybernetes Div., Hagan Chemicals & Controls, Inc., P.O. Box 1346, Pittsburgh 30, Pa.*

For more information circle **255** on inquiry card.

28 volts powers this transistorized vibration amplifier



Consuming only a fraction of the power required by tube type units, taking ⅓ the space, and operating directly from a 28 volt battery, this GLENNITE transistorized amplifier fills all requirements for airborne application.

Unique design and rugged construction assure extremely low microphonics, provide high input impedance for direct use with piezoelectric accelerometers.

A companion light weight, 3-channel battery pack is available. This unit contains a rechargeable, sealed nickel cadmium battery capable of powering 3 transistorized amplifiers for 16 hours.

Like more data on these units? Contact your local Gulton representative, or write us direct.

SPECIFICATIONS

Gain: Continuously variable from 10 to 100
Input impedance: 30 megohms minimum
Power input: 28 v dc at less than 3 ma
Frequency range: 10 cps to 20 KC
Temperature range: up to 200° F

Call in Gulton

Whether you need a single instrument or a complete system, Gulton is capable of meeting all your needs in shock and vibration measurement from transducer to readout equipment. Call in a Gulton Instrumentation Engineer on your next assignment — or on your present one if you have a problem.

GULTON INSTRUMENTATION DIVISION

GI **Gulton Industries, Inc.**
Metuchen, New Jersey

For more information circle **105** on inquiry card.

new cox frequency converter

The new Cox Frequency-to-Analog Converter joins the ever growing list of precision instruments designed and built for electronic data handling by the Cox Instruments Division — pioneers in precision flow measuring equipment.

The Type 2 Converter was originally developed for use with the Cox Turbine Flow Measuring System, but is now being widely used in many other applications for extremely linear conversions in telemetering, computers and other transducer-recorder systems. Its high sensitivity, excellent stability and fast transient response combined with low cost, make it an outstanding converter for all around use.

A new technical bulletin describing the Type 2 Frequency Converter is available upon request. Write to *Cox Instruments Division, George L. Nankervis Company, 15200 Fullerton Avenue, Detroit 27, Michigan.*

SPECIFICATIONS

Range	100 to 5000 cps (other ranges available)
Linearity	.1 per cent over 10:1 range
Stability	.1 per cent
Transient Response	1 millisecond
Price	$300 f.o.b. Detroit

cox instruments

Precision Instruments Since 1912

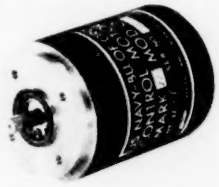
GLN-258

For more information circle **106** on inquiry card.

NEW INSTRUMENTS

SERVO MOTOR

New powerful, continuous duty, hi-temp, Size 23 Servo Motor, Type 23-5251-01, built to BuOrd Mark 21 Mod O specifications meets SAE precision control motor requirements according to ARP 497, essential requirements of

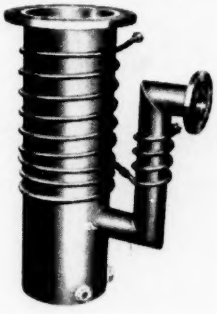


MIL-S-17087 and environmental requirements of MIL-E-5272A. No-load speed is 5000 rpm stall torque 6.5 in oz, rotor moment of inertia 15.5 gm cm^2, ambient temperature range −54°C to +125°C and weight 32 oz. Rating is 115v on phase 1 and 115/57.5v on phase 2, with power input 22 watts per phase at stall.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **256** on inquiry card.

HIGH-SPEED DIFFUSION PUMP

New Type EP4W 4" fractionating-oil 3-stage Diffusion Pump is water-cooled and has a 420 l/sec speed



at 5×10^{-5} mm Hg, and backstreaming is 0.04 cc/hr at 25°C. The extra high limiting forepressure tolerance, 525 microns at 5×10^{-5} mm Hg, gives the EP4W excellent booster action qualities.—*Vecco Vacuum Corp., 86-P Denton Ave., New Hyde Park, L. I., N. Y.*

For more information circle **257** on inquiry card.

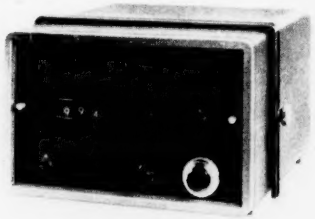
UNREGULATED POWER SUPPLY

New "V" series of unregulated heavy-duty d-c power supplies featuring semi-conductor rectifiers includes Model V40-15 which has a continuously-variable output voltage of 0-40v at 0-15 amps. a-c input is 115v, single phase, 60 cps. Other models in the "V" series have output voltages up to 300v at varying current ranges of 0-2 amps up to 0-15 amps.—*Universal Electronics Co., 1720 Twenty-Second St., Santa Monica, Calif.*

For more information circle **258** on inquiry card.

STRAIN GAGE READOUT

New Universal Strain Gage Indicator, Model UDTI-2, a servo null-balance instrument furnishes digital read-out from any transducer using bonded or unbonded strain gages.



Standard readout ranges are: 0-200, 0-500, 0-1000, 0-2500, 0-3000, 0-4000, 0-5000. In multiple-transducer installations, the new indicator can read all of the transducer outputs over a wide span range, 1 to 5 mv/v. For calibration, the UDTI-2 stimulates transducer output voltages from 0 to 5 mv/v. Basic indicator accuracy is $\pm 0.15\%$ of full scale range.—*Performance Measurements Co., 15301 W. McNichols Rd., Detroit 35, Mich.*

For more information circle **259** on inquiry card.

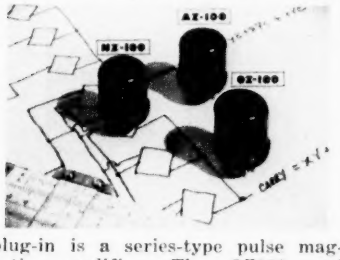
WELDING POWER SUPPLY

New Resistance Welding Power Supply, Model 1024, features controlled output from 2 to 500 watt-seconds. Operating from any 105-125v, 60-cps power outlet, the air-cooled Model 1024 works with the controls and welding transformer of a separate welding head or handpiece. 2-page bulletin describes and specifies unit.—*Weldmatic Div. of Unitek Corp., 380 N. Halstead Ave., Pasadena, Calif.*

For more information circle **260** on inquiry card.

LOGIC SYSTEM MODULES

New Magnalog Logic System basically consists of three interchangeable miniature 7-pin modules which are a "NOT" (NZ100), an "OR" Zener diode (OZ100), and an "AND" Zener diode (AZ100). The NZ100



plug-in is a series-type pulse magnetic amplifier. The OZ100 and AZ100 modules consist of silicon double anode, Zener diodes. Energized by a 100-kc RF power supply it can, for instance, display numbers in prescribed order on a digital readout unit.—*Hoffman Electronics Corp., Semiconductor Div., 930 Pitner Ave., Evanston, Ill.*

For more information circle **261** on inquiry card.

For more information circle **107** on inquiry card.

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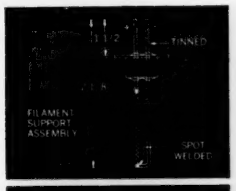
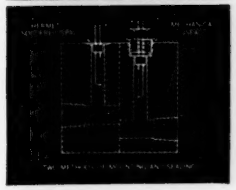
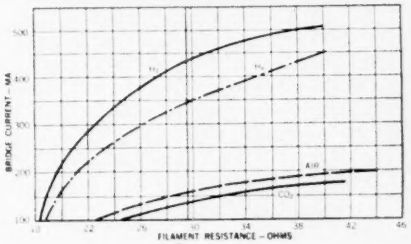
GOW-MAC
HIGH POSITIVE COEFFICIENT RESISTANCE FILAMENTS

For Repair, Experiment and Instruction with

- **Detectors for Gas Chromatography**
- **Gas Analysis by Thermal Conductivity**
- **Temperature Resistance Measurement — 60 ohms maximum working resistance without destruction**







METAL	FORM	RESISTANCE (OHMS) COLD	RESISTANCE (OHMS) OPERATING	CURRENT IN AIR AT ROOM TEMPERATURE MILLIAMPS D.C.	PRICE PER PAIR*
TUNGSTEN	HELIX	20	30	150	$10.00
TUNGSTEN .GOLD PLATED.	HELIX	18	27	150	20.00
KOVAR (ALLOY OF NICKEL, COBALT, IRON)	STRAIGHT	4	7	200	10.00

TUBE NUTS AVAILABLE. CAT. No. 9611 (Brass) . . . Price Per Pair .50

*Minimum order $50.00

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- **Power Supplies (20 V., 500 ma. D.C.)**
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GAS ANALYSIS BY THERMAL CONDUCTIVITY SINCE 1935

For more information circle **108** on inquiry card.

NEW INSTRUMENTS

KINETAPE CONVERTER

New transistorized Converter 768H-1 provides high-speed transmission of digital data from magnetic tape (IBM or Univac) over voice-quality tele-

phone circuits. Data rate is 300 characters per sec. Unit has automatic error detection and correction by error coding and data retransmission techniques.—*Collins Radio Co.*, 2700 *West Olive, Burbank, Calif.*

For more information circle **62** on inquiry card.

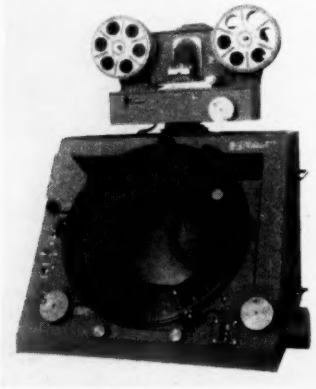
FLOW SWITCH

New FS4 Series of Flow Switches activates signals, pumps, burners, etc. when flow in a pipe line starts or stops. Installation is in 1" pipe tap. Available in two UL-listed models for line voltage, and two for self-generating millivolt systems.—4-page Bulletin FS-1 contains details. —*McDonnel & Miller, Inc.* 3500 *N. Spaulding Ave., Chicago* 18, *Ill.*

For more information circle **140** on inquiry card.

MOTION ANALYZER

New C-11 D Projection Case with 11"-dia screen is suitable for automatic x-y, angle, and frame-count readings directly to IBM card punch or Clary printer systems. Projection heads for 8-,16-,35-, or 70-mm film are available. After manually positioning the crosshairs and angle screen,

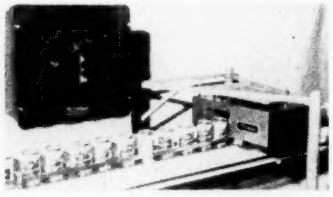


the operator presses a button which automatically reads out the data. Coordinate readout is in increments of 0.001" at the magnified screen image and angle measurement is to 0.1°.—*Vanguard Instrument Corp.*, 184 *Casper St., Valley Stream, L. I., N. Y.*

For more information circle **376** on inquiry card.

FILL INSPECTION SYSTEM

New automatic AccuRay Individual Container Fill Inspection and Rejection System measures the height of filled materials in individual tin cans

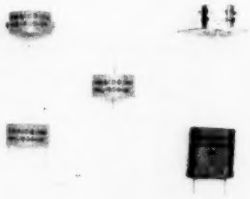


or other containers to 1/64", at speeds of 1000 containers/min, then actuates a rejection device to remove from the conveyor line any container which does not conform to specifications. The system has two principal components: (1) A measuring head incorporating a long-lived isotope energy source and detector, and (2) a control unit which measures the voltage received from the detector and which generates a reject signal whenever required.—*Industrial Nucleonics Corp.*, 1205 *Chesapeake Ave., Columbus* 12, *Ohio.*

For more information circle **262** on inquiry card.

SUBMINIATURE TOROIDS

New line of encapsulated subminiature toroids is based on four core types with identical dimensions (0.670" diameter x 0.360" high) but different magnetic characteristics.



The four cores cover an inductance range from 0.056 mh to 1.0 h, and the frequency range for normal use extends from 1,000 cps to 500 kcps. Hermetically-sealed toroids are packaged in either a can with a flange or a "crystal holder" type can with pins to fit a standard crystal socket.—*Toroids, Inc.*, 18228 *Parthenia St., Northridge, Calif.*

For more information circle **263** on inquiry card.

LOW-CAPACITY LOAD CELLS

New Way-Pac series Load Cells with 0 to 1000 lb capacity feature a moulded rubber diaphragm together with a unique piston positioning device consisting of three stainless steel balls. Accuracy is well within ¼ of 1% of range. Included in line are compression, tension, cable tension, dynamometer cells; tank pivots; indicators and recorders.—*The A. H. Emery Co., New Canaan, Conn.*

For more information circle **264** on inquiry card.

AIR/GAS CLEANER

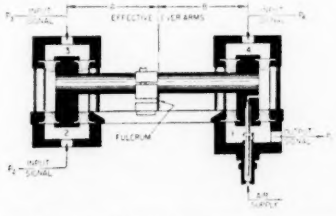
New Vape-Sorber, a hydrocarbon vapor adsorption device protects air and gas systems from the effects of

oil vapor, free oil, water-oil emulsions and dirt. First stage removes droplet and dirt; second stage removes mist and fog by passing the compressed air or gas through an adsorbent.—*Selas Corp. of America, Dresher, Penna.*

For more information circle **265** on inquiry card.

RATIO TOTALIZER

New MSP-120 Ratio Totalizer is a low cost, pneumatic control unit which has been redesigned with greatly reduced spring rate for greater overall accuracy. A four-chambered force-balance device, it combines up to three input signals to produce a

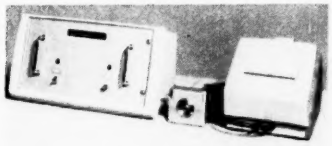


single output signal pressure. It functions both as a controller and computer, providing proportional, integral and rate actions as well as addition, subtraction, multiplication and ratio functions as required. Interchangeable diaphragm and bellows elements are available for input pressures up to 600 psig.—*Hagan Chemicals & Controls, Inc., P. O. Box* 1346, *Pittsburgh* 30, *Pa.*

For more information circle **266** on inquiry card.

DATA LOGGING SYSTEM

New K-120 System provides recording up to three decimal digits (0-999) on adding machine tape from various makes of self-balancing potentiometers (SBP) such as Bristol, L & N, and Honeywell. Automatic initiation can be from a timer, clock, or upon

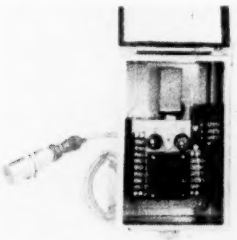


demand. Accuracy is ±0.1%. Speed is 2 readings/sec. Selection of over 100 different encoder readings is available with a variety of ranges such as 0-799, 0-499, 500-999, etc. Basic components are a C-100A Series Encoder, a K-120 Control Chassis, and the DATEX-Monroe MC-202 Data Log.—*Datex Corp., 1307 So. Myrtle Ave., Monrovia, Calif.*

For more information circle **267** on inquiry card.

PROXIMITY SWITCH

New Proximity Limit Switch, Type 2782, uses maker's differential transformer transducer as the sensing de-

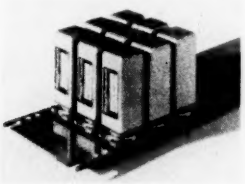


vice eliminating the need for light beams, mechanical linkage or physical contact and has no calibrated transmission cables nor special power supplies.—*ATC, Inc., Dept. 201, King of Prussia, Penna.*

For more information circle **268** on inquiry card.

DIGITAL CIRCUITS

New complete line of Transistor Digital Circuits is fully encapsulated and comes in two package styles and

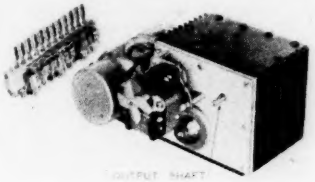


three temperature ranges (−10° to +60°C, −10° to +71°C, and −55° to +71°C). Package Style A (illustrated) is for mounting in 9- and 14-pin miniature tube sockets. Package Style B is for 15 pin in-line mounting. Designed for 100-kc operation, they permit operation up to 200 kc, and in some cases, up to 400 kc.—An engineering brochure and engineering bulletins contain details.—*Epsco, Inc., 588 Commonwealth Ave., Boston, Mass.*

For more information circle **269** on inquiry card.

TRANSMISSION UNIT

New multi-purpose, Class 3 commercial-type unit features low-inertia gear train for instantaneous speed changing. Gear ratio with optional low-speed motor (in 12 steps) is 2,560 to 1. With transmission drive motor, it covers a ratio of 128 to 1 in eight steps. Another 256-to-1 ratio (in 12

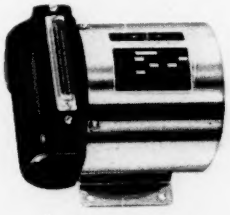


steps) is obtained with use of optional dual-speed transmission motor. Output torque is 128 in oz. Maximum breakaway torque is six in oz., and top running torque is four in oz. Control is by optional push-button switch.—*The Hamilton Watch Co., Hathaway Instrument Div., 5800 East Jewell Ave., Denver 22, Colo.*

For more information circle **270** on inquiry card.

MINIATURE EVENT RECORDER

New miniature 25-channel inkless recorder, ER-125, finds use for recording data from special transducers, and as a telemetering back-up device, besides missile applications. A

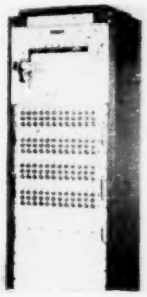


transistorized time base operating at 10 cps is furnished with the standard Model: available as optional, is a 100 cps time base for greater time resolution. A 27-vdc (governor-controlled) motor of ruggedized construction is coupled to a gear reduction train driving the tape transport system at a nominal 5 ips. The recording tape is either metalized Mylar 0.0015" thick or chemically-treated Alfax paper.—*Santa Barbara Instrumentation Corp., 5481 Santa Monica Blvd., Los Angeles 29, Calif.*

For more information circle **271** on inquiry card.

STRAIN-GAGE CONTROL

New strain gage recording systems for balancing, calibrating, controlling, scanning and recording the output of 24 to 96 strain-gage channels feature modular construction. B system prints



strain values in sequence together with channel number, while C system plots strains vs load for each channel. Digital readout is available and strains can be tabulated on a typewriter, IBM cards, or punched tape.—*B & F Instruments, Inc., 3644 North Lawrence St., Phila. 40, Pa.*

For more information circle **101** on inquiry card.

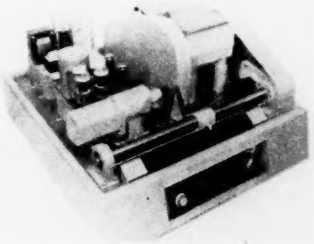
TESTING UNIT

New Model 8000 hermetic Compressor Analyzer and Electrical Tester for all makes in the air conditioning and refrigeration industry, consists of five individual instruments—hermetic motor starter; dual-range volt meter; dual-range capacitor analyzer; non-destructive breakdown tester; 3-phase tester with phase sequence indicator. Bulletin gives details.—*Airserco Mfg. Co., Inc., 435 Melwood Ave., Pittsburgh 13, Pa.*

For more information circle **109** on inquiry card.

CONTROL SYSTEMS

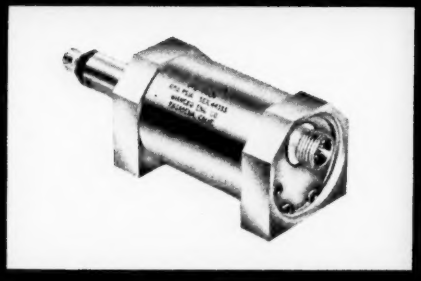
New electromechanical control systems of improved dynamic response, high accuracy and assured repeatability can be used with computers or with signal sources sensing linear



motion or distance, pressure, temperature, flow, and speed; or manual controls. Modular system consists of a signal comparator (electrical or mechanical), a power-supply converter, electronic amplifier, and mechanical power amplifier. Output may be either uni- or bi-directional.—*Seneca Falls Machine Co., Electronics Div., 12 Fyfe Bldg., Seneca Falls, N. Y.*

For more information circle **110** on inquiry card.

a variable-reluctance pressure transducer for dc applications



Wiancko's new dc-dc pressure transducer is a notable advance in transducer design that will find ready acceptance and wide appreciation because here, combined in a small 10-ounce package, are all the advantages of the variable-reluctance pick-off with the desirable features of dc excitation and output. High output (0-5 volts dc), great accuracy and repeatability, exceptional acceleration and vibration resistance, constant output impedance, and high frequency response, all make this transducer eminently suitable for telemetering and data system applications.

Available in gage, absolute, and differential models, this new Wiancko achievement will soon be incorporated in accelerometers and force rings. For more detailed information, write for Product Bulletin 108.

Wiancko

Wiancko Engineering Company
255 No. Halstead Avenue • Pasadena, California

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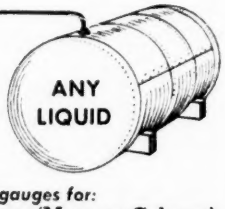
For more information circle **111** on inquiry card.

TANK•METER
FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY



TANK MAY BE BURIED, ELEVATED, OPEN, CLOSED, VENTED OR UNDER PRESSURE OR VACUUM

SEND FOR BULLETINS

Also gauges for:
Barometric Pressure (Mercury Column)
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Pressure and Vacuum
Differential Pressure
Inclined Manometers for draft, pressure or differential pressure.

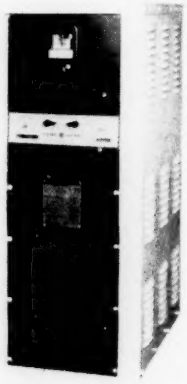
UEHLING INSTRUMENT CO. 470 GETTY AVE., PATERSON, N. J.

For more information circle **112** on inquiry card.

NEW INSTRUMENTS

STRIP CHART RECORDER

New null-balance strip chart recorder-controller features continuous standardization by silicon (Zener) diode, and unitized construction, with printed circuits and plug-in components. Available as d-c potentiometers,

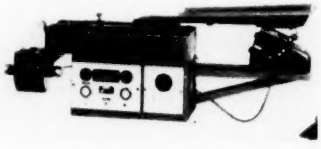


a-c or d-c bridge; and both single-pen (type HF) and multi-record (type HG) types, it has 10¾" calibrated chart width. The new instrument can be used to record watts, vars, power factor, and frequency, or pH conductivity, temperature, flow and pressure.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **272** on inquiry card.

AUTOMATIC BATCHER

New portable FCB-1 unit can feed count, batch, and tabulate 300 to 1000 small pieces per min. Unit consists of a Syntron vibrating tray, a special



conveyor belt (with speeds up to 150 ft/min), a photoelectric sensing device, and a Decitron Preset Counter. Units with total counts from 1 to 1,000,000 are available.—*Post Electronics, Div. of Post Machinery Co., 165 Elliot St., Beverly, Mass.*

For more information circle **273** on inquiry card.

VISCOMETER

New measuring elements for high-pressure reactors and pipe lines use a proximity switch for timing the fall of a piston through the liquid in the process. The piston is intermittently raised by a mechanical lifting mechanism and then allowed to fall by gravity. A recorder controls the fre-

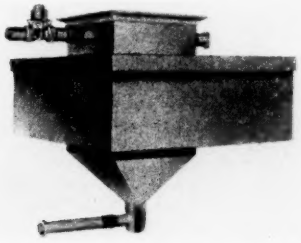
quency of lifting, receives the time signals from the measuring element, and converts the time of fall data in-

to a complete viscosity record.—*Norcross Corp., Dept. #N45, Newton 58, Mass.*

For more information circle **274** on inquiry card.

BATCHING SCALE

New Low-A-Trol constant-feed Batching Scale features electronic closed-circuit control providing dynamic accuracies of 0.1% for wet or dry materials being fed at rates of from 5 lb to 5 tons/hr. The scale orders periodic filling of the hopper as needed. A servomotor positions a

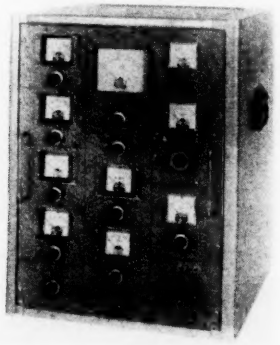


poise on the balance beam. The poise is retracted at a constant preset rate by a velocity servo system. A rotary feeder discharges the hopper at a rate dependent on the withdrawal rate of the poise, and a weight sensing element detects the unbalance and controls the speed of the rotary feeder. —*Thayer Scale Corp., Thayer Park, Pembroke, Mass.*

For more information circle **275** on inquiry card.

POWER SUPPLY

New versatile Model 250 Traveling Wave Tube Power Supply has electrode supplies which are floating and



isolated with respect to each other.—2-page bulletin contains details.—*Alfred Electronics, 897 Commercial St., Palo Alto, Calif.*

For more information circle **276** on inquiry card.

. . . on the computer reel

FOR HIGHEST-PRECISION COMPUTER APPLICATIONS . . .

has three important features*

Type EP Audiotape is the extra-precision magnetic instrumentation tape that is guaranteed defect-free. Now EP Audiotape is available in a form particularly suited to electronic computers. It is made on both 1.5-mil cellulose acetate and polyester film. Tapes are 2500 x ½". Every reel is tested by a 7-channel certifier before it leaves the factory and is guaranteed to have absolutely no "dropouts" (microscopic imperfections causing test signal to drop below 50% of average peak output).

* **Reel** is Audio's computer reel – an opaque polystyrene 10½" reel with a hub diameter of 5.125". Each reel comes with pressure-sensitive identification labels and a yellow polyethylene drive slot plug.

* **Two photo-sensing markers** are accurately placed on the tape, one 14 feet from the hub end, the other ten feet from the other end. These markers are vaporized aluminum sandwiched between the base and low flow thermosetting adhesive. Both markers are firmly placed and wrinkle-free.

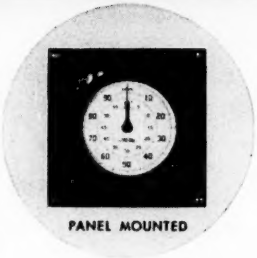
* **Container** is of transparent polystyrene and made especially for the computer reel. A center-lock mechanism and peripheral rubber gasket seal the reel from external dust and sharp changes in temperature and humidity.

EP Audiotape on the computer reel has been used in large computer installations with perfect results. Although the reel, markers and container are designed for specific computers, the tape is the same precision EP Audiotape that has stood the tests of time and operation on hundreds of applications in automation, petroleum seismology, telemetering, and electronic computing. To get the complete specifications for type EP Audiotape on the computer reel – or for a Company representative to call – write on your company letterhead to Dept. TI

AUDIO DEVICES, INC., 444 Madison Avenue, New York 22, N. Y.

precision timers by... STANDARD TRADEMARK

Industry's preferred "instrument of a thousand uses". Accurate, rugged, versatile STANDARD Elapsed Time Indicators. Synchronous motor drive. Electric clutch controlled by manual or automatic switch or output of electronic tubes. Manual or electric zero reset. Units for flush panel mounting or portable use.



PANEL MOUNTED

Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

PORTABLE

Request Bulletin No. 198.

THE STANDARD ELECTRIC TIME COMPANY

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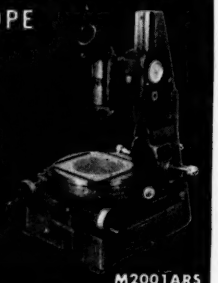
For more information circle 114 on inquiry card.

GAERTNER TOOLMAKERS' MICROSCOPE

Co-ordinate range 4 x 2. Provides easy, convenient operation, high setting and repeating accuracy.



M200TARS

MINIMIZE REJECTS!

Precise measurement to 0.0001" and 1 min. of arc

A reliable, easy-to-use microscope for precise measurement of piece parts, tools, dies, thread gages, templates, jigs, fixtures, etc. You make direct, non-destructive measurements — no contact, no distortion, images are sharp and clear.

Used by U. S. Govt. Gage Laboratories, and by prime contractors and their subcontractors. Use of the same measuring instrument by all parties co-ordinates inspection procedures, and minimizes disagreements and rejects.

Write for Bulletin 147-56

The Gaertner Scientific Corporation

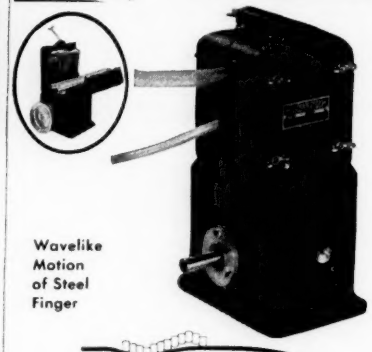
1211 Wrightwood Ave., Chicago 14, Ill.
Telephone: BUckingham 1-5335

For more information circle 115 on inquiry card.

PUMP

Liquids
Gases
Slurries

WITHOUT CORROSION or CONTAMINATION



Wavelike Motion of Steel Finger

Forces Material Through Tubing

Capacities 0.2 cc. per min. to 4.5 G.P.M.

Prices range from ..... $60.00 to
depending on size $550.00
and accessories

Write for Catalog.

SIGMAMOTOR, INC.

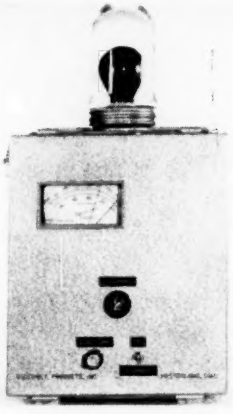
49 North Main St. • Middleport, N. Y.

For more information circle 116 on inquiry card.

NEW INSTRUMENTS

24-STATION MONITOR

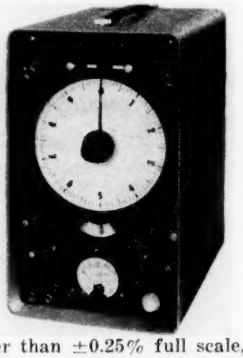
New fail-safe scanning control checks 24 stations in order, 12 per min. Almost any measurable variable can be monitored. Signals from thermocouples or other sources are indicated continuously by the moving pointer of the meter-relay. A visual or aural alarm is given if the indicating pointer touches either a high or low limit pointer. For quick trouble-shooting, the number of the station affected is shown in a Burroughs tube.—*Assembly Products, Inc., Chesterland, Ohio*



For more information circle 277 on inquiry card.

TRANSDUCER CALIBRATOR

New ElectroSyn Model 850 Precision Indicator is a precision read-out device, for rapid calibration of pressure gages, transducers, etc. Accuracy is better than ±0.25% full scale, linearity is ±0.15%, optical resolution is 0.05%, and reproducibility is 0.1%. —*Norwood Controls, Div. of Detroit Controls, 934 Washington St., Norwood, Mass.*



For more information circle 278 on inquiry card.

TEMPERATURE TRANSDUCERS

New line of 100-ohm-resistance transducers for measurement of fluid, air, and surface temperatures feature rapid response (200 msec) as a result of the deposited-platinum film used as sensing element. The fluid-immersion transducer (4101L-11)

measures temperatures of static or moving fluids. The air transducer (4101H-10) operates in static to high-velocity gases. The surface transducer (2101H-15) permits temperature measurement on materials of limited

area and thickness. Calibration accuracy is as follows: Fluid-immersion type—0.5% (0.1F in LOX temperature range); air and surface types—0.5% (range from −100 to +500°F), 1.0% (range from −100 to +1200 F).—*Arnoux Corp.*, 11924 *W. Washington Blvd., Los Angeles 66, Calif.*

For more information circle **279** on inquiry card.

BRAZING TUBE FITTING

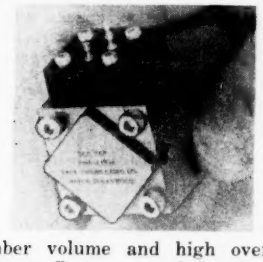
New Braze-lok fitting for brazed tube connections in certain high pressure service has a pre-positioned silver alloy brazing ring which produces a permanent liquid-tight, gas-tight

joint in a matter of a few seconds. Available in sizes of ¼" through 2" O.D. They can be furnished in steel, stainless steel, naval brass, cupro nickel or other materials.—4-page Catalog 4375 provides descriptive information.—*Parker Fittings & Hose Div., Parker-Hannifin Corp.*, 17325 *Ave., Cleveland 12, Ohio*

For more information circle **280** on inquiry card.

PRESSURE TRANSDUCERS

New Model P21 variable-reluctance Pressure Transducer features a diaphragm magnetically coupled to a pick-off system embedded in the body as the sensing element, low pressure



chamber volume and high overload tolerance. Ranges are from 1 psi to 1000 psi (gage, differential, and absolute) with an accuracy rating of ±0.5% full scale. Constructed of Type 416 stainless steel it weighs 4½ oz and is 1-3/32" square and 1 $\frac{\lambda}{16}$" thick. —*Pace Engineering Co.*, 6914 *Beck Ave., North Hollywood, Calif.*

For more information circle **281** on inquiry card.

GULTON SHOCK AND VIBRATION DATA FILE

How to avoid false test results due to "ground loop" voltages

With the increasing need for greater accuracy in shock and vibration measurement, extreme care should be taken to avoid the introduction of spurious voltages.

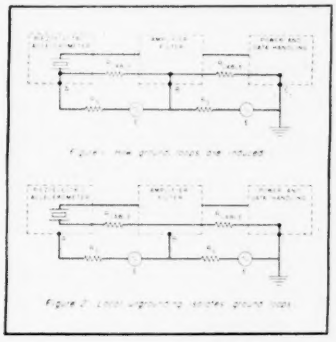
Circulating ground currents, generated by electrical devices external to the measuring system, generate voltages that can lead to completely false results.

GROUNDING USUALLY AT FAULT

Ground loops may come from various extraneous sources.

Figure 1 shows how circulating ground currents in a structure can induce electrical voltages in a typical shock and vibration measuring system. In this example, the accelerometer, amplifier and data handling or recording equipment are placed at three separate locations. Each instrument has its electrical circuitry grounded to the housing, and each housing is connected electrically to the structure at points A, B and C.

Voltages E, produced in the structure by the circulating currents, are introduced into the measuring system between points A&B and B&C.



SOLUTION TO THE PROBLEM

First, all electrical apparatus capable of generating currents should be ungrounded and a *single heavy point ground* employed.

Second, all measuring instruments should be ungrounded at local points and the entire system grounded at the single point.

Anthony W. Orlacchio
Chief Engineer
Gulton Instrumentation Division

Figure 2 illustrates a recommended technique for ungrounding the system described in Figure 1. By removing the internal circuit grounds from structural points A and B, ground loop voltages are isolated from the measuring system.

UNGROUNDED INSTRUMENTS THE ANSWER

Today, a new series of Gulton accelerometers and associated electronic equipment is available with *internal ungrounding.*

Accelerometers contain sensitive seismic elements insulated from mounting studs by rugged ceramic insulation.

Filter and amplifier circuitry, as well as connectors, are electrically insulated from the housing which can then "float" at the local ground potential of the mount with no effect upon the measuring signal.

SEND FOR TECHNICAL DATA

For more complete information on Gulton ungrounded instrumentation systems, contact your local Gulton representative or write us direct.

FREE TECHNICAL SERVICE OFFERED BY GULTON

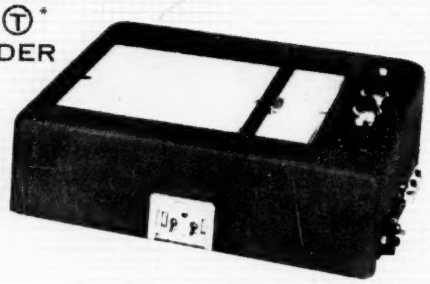
A Gulton Instrumentation Engineer will gladly call at your request to help you with instrumentation problems. You are invited to put his extensive experience in shock and vibration measurement to work for you.

GULTON INSTRUMENTATION DIVISION
Gulton Industries, Inc.
Metuchen, New Jersey

For more information circle **117** on inquiry card.

MODEL 2S
X-Y-Ⓣ*
RECORDER

11" x 17"
Recording Table
(Vacuum Grip)



Y = 5 mv to 500 volts*

* with TIME BASE

X = 7.5 mv to 500 volts (or) 7.5 to 750 seconds

THE MOSELEY

AUTOGRAF

A DIRECT WRITING, LOW FREQUENCY OSCILLOGRAPH for:

X-Y RECORDING — Automatically draws curves directly from a variety of electrical data.

CURVE FOLLOWING — With adaptor, regenerates functions from original curves traced with conducting ink.

POINT PLOTTING — Plots points directly from Keyboard; with translator, plots from Card Punch or Tape Reader.

FUNCTION vs TIME — Automatically plots dependent variable against TIME. (5 Sweep Ranges)

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For more information circle **118** on inquiry card.

the leading contender in the sensitive relay class!

KURMAN'S
MIGHTY SERIES "T"
Compare it and you'll know why

★ .975" x .975" x 1¾" high
★ Up to DPDT – 2 amp. 28V. DC, 115V AC
★ Sensitivity down to 6 milliwatts
★ Coil Resist. up to 20,000 ohms
★ Will meet MIL-R-5757C

The latest addition to a line of miniature hermetically sealed sensitive relays, the new Kurman Series "T", weighing only 3½ oz., is now available—the mighty midget of the sensitive class. Radically different in design, you will find the Series "T" to be superior in performance — economically priced with excellent delivery service.

Why not specify the Series "T" for your next sensitive relay application and check its performance for yourself? Write to Dept. I A for detailed specification sheet.

KURMAN ELECTRIC CO.
DIVISION OF NORBUTE CORP.
Quality Relays Since 1928
191 Newel Street, Brooklyn 22, New York

For more information circle **119** on inquiry card.

SPOT
CRITICAL
TEMPERATURES
ACCURATELY
with

NEW PYRO
MICRO-OPTICAL PYROMETER

All-purpose PYRO Micro-Optical precisely measures targets as small as .001" in diameter or objects at remote distances to 2°C reproducibility! Temperature scales 700° - 3200°C (1300° - 5800°F).

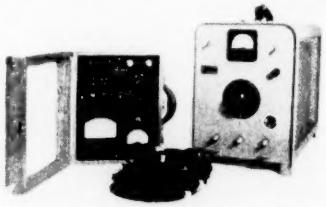
Send for FREE catalog No. 95.

PYROMETER INSTRUMENT CO., INC.
BERGENFIELD 4, NEW JERSEY

For more information circle **120** on inquiry card.

LOW-R OHMMETER

New low-resistance test set measures resistance values as low as 1 microhm within 2% accuracy. The portable set consists of a Model 151-S Microhm Meter plus a transistor-type Model SM Rectifier for supplying

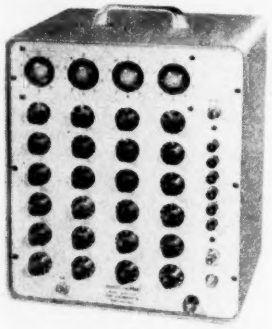


both a 10 amp dc and a 100 amp d-c current source. The Microhm Meter has also its own self-contained 10-amp battery power supply. Set can be used for checking the conditions of oil and air circuit breaker resistance in cable joints, bus bar connections, and current paths in other power equipment where the normal resistance is in the microhm range.—*J. W. Dice Co., Englewood, N. J.*

For more information circle **282** on inquiry card.

PRESET COUNTERS

New 2020 Multiple Preset Counters have multiple groups of presetting controls for high-speed sequential predetermining counting and control.



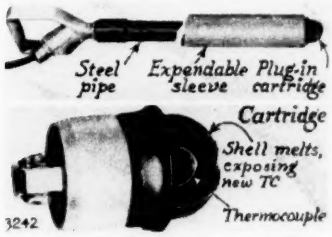
Complete programs can be preset. Various inputs, including photocell, mechanical contacts, or pulses, can be utilized at counting speeds up to 30,000 per min.—*Freed Transformer Co., Inc.*, 1707 *Weirfield St., Brooklyn* 27, *N. Y.*

For more information circle **283** on inquiry card.

EXPENDABLE TC

New immersion thermocouple for molten-steel temperatures consists of a length of standard 1" black iron pipe with a handle on one end and a fitting on the other to hold a cartridge. The cartridge, and a 4-ft paper sleeve protecting the immersed length of pipe, are the only expendable items. The cartridge is a refractory cylinder with contacts at the receptacle end and a platinum/platinum-10%-rhodium thermocouple enclosed in a U-shaped sheath. Hemi-

spherical sheet-steel cap enclosure melts away to expose the couple. Factory-sealed units offer new-thermocouple accuracy, with high-speed measurements. Instead of the usual



20-45 sec readings take now 5 sec. One-shot item is said to be comparable in cost with present methods. A recorder conversion kit adapts conventional recorders to fast speed or a new Speedomax G recorder can be used with the new couple.—*Leeds & Northrup Co., 4970 Stenton Ave., Phila. 44, Pa.*

For more information circle **284** on inquiry card.

FORGED NEEDLE-VALVES

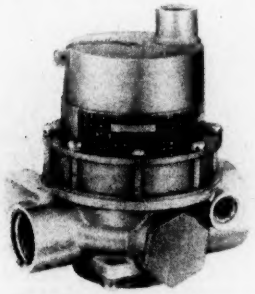
New Series 100 general purpose, forged needle-valves in angle or globe pattern for 10,000 psi service are

guaranteed leak-proof through the packing from non-critical vacuum to 10,000-psi (WOG) service and have operating-temperatures range from −40°F to 500°F.—*Hoke, Incorporated, 128 Tenakil Rd., Cresskill, N. J.*

For more information circle **285** on inquiry card.

AIR PRESSURE REGULATOR

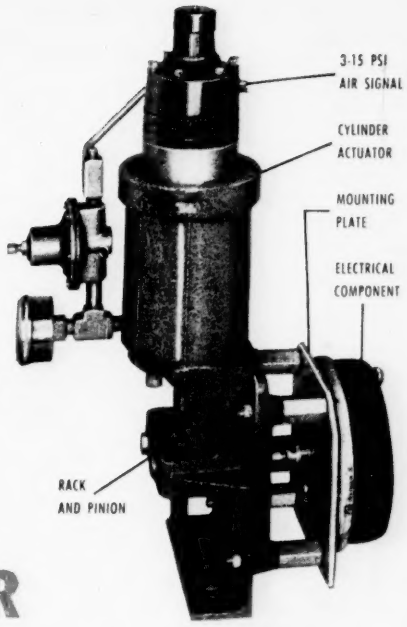
New high-flow pilot-type regulator maintains an outlet pressure of 6±0.25 psig with flow variations from 3



to 160 scfm under 10 to 250 psig inlet pressure and −65 to +350°F.—*Clary Dynamics, 408 Junipero St., San Gabriel, Calif.*

For more information circle **286** on inquiry card.

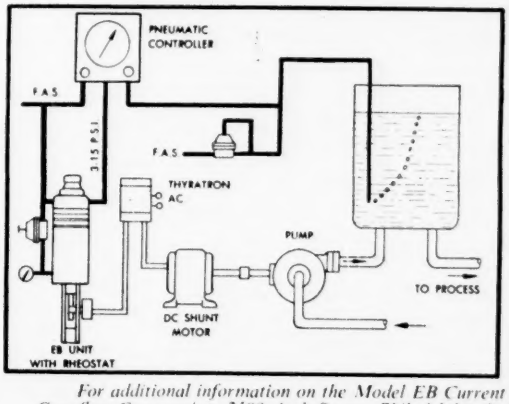
ELECTRIC CONTROL FROM A PNEUMATIC SIGNAL WITH THE CONOFLOW MODEL EB CURRENT CONTROLLER



The Model EB Current Controller—an exclusive product of Conoflow Corporation—is a unique final control element. It is a pneumatic-electric transducer consisting of a pneumatic cylinder actuator fitted with a rack and pinion mechanism, and a standard electrical component such as a rheostat, potentiometer or autotransformer. The cylinder actuator, operating from a 3-15 psi air signal, produces a rotary motion (to 360°) to precisely position the electrical device affording automatic control of voltage, current, inductance, capacitance, resistance, or other electrical values.

APPLICATIONS—Conoflow Model EB Current Controllers are available from the factory in over 200 combinations of electrical components to handle a wide variety of applications. A few of these include:

- **Constant Pressure**
- **Proportional Flow**
- **Liquid Level**
- **Temperature Control**
- **Machine Tool Speed**
- **Conveyor Control**
- **Heat Treating**
- **Humidity Control**



A TYPICAL EXAMPLE

Direct flow regulation by varying pump speed is accomplished when the EB unit is used with a pneumatic controller and an electronic speed changer. It automatically positions the small rheostat in the grid circuit of a thyratron controlled speed changer, thereby adjusting motor and pump speed. This method of flow rate control can be used to provide control of temperature, pressure, pH, interface, or liquid level. It eliminates the valve, reduces motor power input, and provides for positive flow rangeability.

The EB unit with cylinder directly coupled to the armature or field rheostat of a DC shunt wound motor is also widely used for motor speed control.

For additional information on the Model EB Current Controller write to Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa., for Bulletin EB-3A.

CC-804

Cono-Controls®

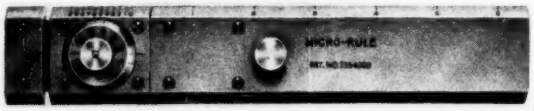
CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

A SUBSIDIARY OF WALWORTH

For more information circle **121** on inquiry card.

THE MICRO-RULE



For the Draftsman, Engineer, Architect, Map-Maker and Navigator

A Modern Device for Accurate Lay-Out Work. Graduations Read to 1/1000 of an Inch. Plainly Visible Without the Aid of a Glass.

MICRO-RULE, as its name implies, is a rule to measure minute distance. Working on an entirely new principle, it provides a means to readily measure and lay out distances to 1/1000 of an inch without eyestrain and without the use of a glass. The graduation lines on the scale end in "V" shaped notches and with the aid of a pricker the distances are transferred to the paper, or other medium, as fine dots.

When measuring distances between lines, the lines are centered in the "V" notches and the distance is read off the scale in thousandths of an inch.

This action is so quick and positive it must be seen to be appreciated.

CATALOG ON REQUEST

Drawing Instruments—Engine Divided Rules—Eleven Point Spacing Dividers—Stainless Steel Straightedges—T-Squares—Triangles for the

DRAFTING ROOM—PATTERN LOFT—LAYOUT TABLE

FOR OVER 100 YEARS THE FINEST INSTRUMENTS MADE

THEO. ALTENEDER & SONS
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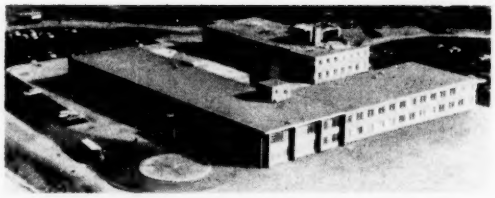
For more information circle **122** on inquiry card.

new plants and mergers



HAGAN CHEMICALS & CONTROLS recently moved into its new 60,000-sq-ft headquarters building and 33,000-sq-ft research center 12 miles from downtown Pittsburgh.

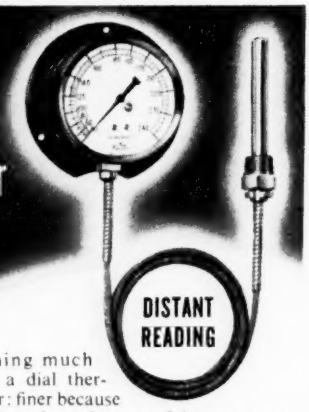
CONSOLIDATED METAL PRODUCTS CORP. has acquired the WALDALE RESEARCH CO., INC. of Pasadena, Calif., as a wholly-owned subsidiary.

U. S. GAUGE has put in operation its new plant representing an investment of $\$1\frac{1}{2}$ million in building and new equipment.

AMERICAN METER CO. reports that its subsidiary, Buffalo Niagara Industrial Controls, Inc., has purchased the BUFFALO METER CO.

CAMBOSCO SCIENTIFIC CO. has cut its catalog costs and increased its quality by using *Polaroid Camera* technique to photograph the thousands of items in its general catalog of scientific laboratory equipment.

The dial thermometer at its best



Something much finer in a dial thermometer: finer because it is the bourdon tube type of thermometer at its best...embodies the greater precision and lasting accuracy of the Marsh Pressure Gauge.

Both vapor tension and gas-filled types are available in either distant reading or rigid stem types. In the broad Marsh line you have a complete selection of temperature ranges, case sizes, styles, and finishes.

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MARSH

MARSH INSTRUMENT CO. Sales Affiliate of Jos. P. Marsh Corp.
Dept. 42, Skokie, Ill.
Marsh Instrument & Valve Co., (Canada) Ltd.
8407 103rd St., Edmonton, Alberta, Canada
Houston Branch Plant, 1121 Rothwell St.
Sect. 15, Houston, Texas

For more information circle **123** on inquiry card.

New Compact

conax®

THERMOCOUPLE HEAD with

- **Light weight design**
- **Simple assembly**
- **Watertight construction**
- **Bright chrome finish**
- **Corrosion resistance**

for

use with 30 gage to 14 gage wire—maximum operating temperature of +300°F. (continuous) or +450°F. (intermittent). Ideal with Conax Thermocouple Glands, Conax Speedwells, Conax Flex-tube Assemblies, Conax Safetywells and other similar applications.

WRITE FOR CONAX DATA BOOK SHOWING COMPLETE LINE OF THERMOCOUPLE ASSEMBLIES AND PRESSURE SEALING GLANDS.

conax corporation
2316 Walden Ave., Buffalo 21, N. Y.

For more information circle **124** on inquiry card.

ALPHA PORTLAND CEMENT CO. recently unveiled its new multi-million dollar fully instrumented plant located at Lime Kiln, Md.

LIBRASCOPE, INC., subsidiary of General Precision Equipment Corp., announces acquisition of PRECISION TECHNOLOGY, INC., which will be incorporated into its engineering division.

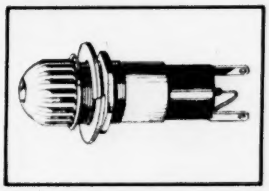
people in the news

THOMPSON-RAMO-WOOLDRIDGE PRODUCTS CO. announces that *James A. Trapp* has been appointed manager of the Data Processing and Controls Department, Engineering Div., and *Dan L. McGurk* has joined the company as proposals and contracts manager.

COOK ELECTRIC has elected *William T. Welsh*, vice-president and general sales manager.

AMERICAN METER CO. reports that its president *William G. Hamilton, Jr.*, who is also chairman of the

Now—*20 TIMES BRIGHTER* Neon Indicator Light Assemblies!



This DRAKE Assembly — No. 101N-022 — is ideal to use with the new G.E. NE-51H High Brightness Neon Glow Lamp, for 125V AC operation. According to the manufacturer, the lamp gives 20 times more illumination than old style neons. Since useful life is 5000 hours, replacement is made easy with Unit No. 101N-022; bulb flickering warns of time to change. Less than ¼ watt power required for operation.

No. 101N-022 has built-in 22,000 ohm resistor — is available with plain or fluted glass or plastic domed lenses, solder or screw terminals. Also available for 250V application (Unit No. 101N). Commercial units are UL listed. This style can be supplied to meet MIL specs.

★ ***SEND FOR FREE SAMPLE, DATA SHEET, and Quick-Reference Catalog of other Assemblies and Lampholders in the big DRAKE line.***

DRAKE MANUFACTURING COMPANY
1711 WEST HUBBARD ST. • CHICAGO 22, ILL.
MINIATURE LIGHTING SPECIALISTS

For more information circle **126** on inquiry card.

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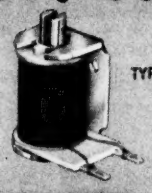

LOW COST
SMALL SIZE
EFFICIENT
POWERFUL

● New, economical, compact design. Extremely efficient, dependable in performance. Available for either AC or DC operation, intermittent or continuous duty. 3 to 220 volts. Normally supplied with flat plunger, but also available with conical plunger for DC only. Send for complete details.

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RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING

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THERMAL CONTROLS AND THERMOMETERS

Specify!
THE BEST!
A half century of experience is back of every instrument we make. You get assured accuracy and long dependable performance when you specify "Philadelphia." Our specialized staff will be glad to discuss your problem in our field.
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PHILADELPHIA THERMOMETER CO.
4401 N. Sixth St. • Philadelphia 40, Pa.

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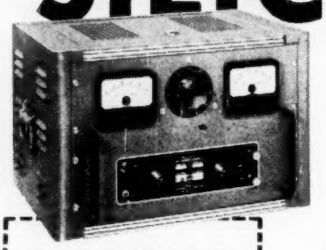
SILICON RECTIFIER POWER SUPPLY



0-32 V.D.C.
40 Amps
½% Ripple
Model KM93B

- Vacuum Varnish Impregnated Magnetic Components
- Short Circuit and Overload Protection
- Non-Ageing Silicon Rectifiers
- Natural Draft Cooling
- 4½" Rectangular 2% Accuracy DC Panel Meters
- BUDGET PRICED

Additional Specifications

Regulation: 12% from 1/10 load to full load at 32v. output
Overload Capacity: 125% of rated current continuously (50 Amps.) at 45°C ambient
Polarity: Pos. Neg terminals are above ground and isolated from AC input.
Input: 115 volts AC 60 cycles single phase
Controls: Switch, fuse, load circuit breaker, voltage control, pilot light.
Terminals: DC output — panel binding posts and terminal board at rear. AC input — barrier type terminal board at rear.
Dimensions: 22"L x 14"H x 15"D **Weight:** 160 lbs.

Also available without cabinet for mounting in standard 19" rack. Panel height only 12¼" inches. Specify Model KM93

Bulletin No. 102 On Request

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Telephone: BEekman 3-7548

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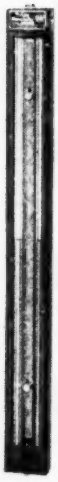
King MANOMETERS

For Plant and Laboratory



King Manometers are rugged, low-cost instruments of unexcelled accuracy for measuring pressure, vacuum, differential pressure, and pressure-related phenomena. They're available in the following types, in a complete range of sizes:

U-Type Manometers
- Single Cleanout
- Double Cleanout
- With 3-Valve Manifold
- Inverted U-Type

Well-Type Manometers
- Low-Well
- Raised-Well
- Barometric-Reading
- Flowmeter Type
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Multi-Tube Manometers
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NEW CATALOG gives details on these and other models—includes manometer liquids and accessories—explains basic principles. Write—

KE INSTRUMENTS KING ENGINEERING CORP.
Box 70 • Ann Arbor, Mich.
REPRESENTATIVES IN PRINCIPAL CITIES

For more information circle **129** on inquiry card.

W. G. Hamilton, Jr.

Robert Lent

E. L. Braun

G. R. Lippert

E. P. Fleischer

E. J. Stephens

board of Canadian Meter Co., Ltd., was elected a Director of the American Gas Association at the association's annual convention in Atlantic City, on October 13.

STATHAM INSTRUMENTS reports promotion of *Robert Lent* from sales manager to director of marketing.

GENESYS CORP. reports the addition to its staff of *Edward L. Braun* as director of systems and electronics.

VICTOREEN INSTRUMENT CO. announces appointment of *George R. Lippert* as director of technical services.

CONSOLIDATED ELECTRODYNAMICS announces appointment of *Edward P. Fleischer* as assistant to the president.

SEQUOIA WIRE & CABLE CO., a division of MANDREL INDUSTRIES announces appointment of *L. Burt Avery* to

FACTORY FOR SALE

Manufacturing Thermometers and Hydrometers. Located in Puerto Rico.

Operating since 1954 with trained labor force, competent manager, machinery, wage rate 88 cents per hour, glass inventory, etc.

Fully income tax exempt.

Majority stockholders wish to withdraw to dedicate themselves to other businesses.

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Mayaguez, Puerto Rico. U.S.A.

Jack T. Teed

John F. Hornor

W. S. Taylor

G. W. McKnight

J. B. Moxness

C. W. Wilkins

vice-president and general manager, and *E. J. Stephens* to the position of general sales manager.

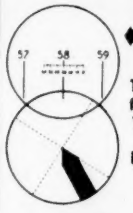
BROWN INSTRUMENTS Div. of Minneapolis-Honeywell announces appointment of the following new market managers: *Jack T. Teed*, petroleum; *Joseph F. Hornor*, metal production and ceramics; *William S. Taylor*, food; *George W. McKnight*, utilities; *John B. Moxness*, pyrometer supplies and accessories; and *Charles W. Wilkins*, laboratory and test instrumentation.

WEST INSTRUMENT CORP. has named *Ardmore M. Willer* sales manager.

VEEDER-ROOT has appointed *Peter H. Morganson* assistant chief engineer.

new SCHERR
TOOLMAKERS MICROSCOPE

WITH INTERCHANGEABLE DIAL TEMPLETS AND OCULARS



Reading Angles in Minutes

Thread Templets for U. S. National Thread Profiles-6-80 Pitch. Radii Templets, etc.

LARGE MICROMETER DRUMS READ DIRECTLY IN .0001"

Measuring Range 2" x 1-1/2" and other sizes

A moderately priced PRECISION MEASURING TOOL for Toolroom and Inspection

WRITE FOR CATALOG—Code YGIIQ

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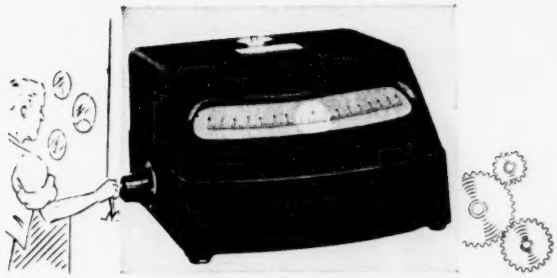
COMPLETE LINE OF PRECISION INSTRUMENTS
WEST COAST BRANCH: SCHERR-TUMICO CO. - 3337 W. Olympic Blvd. - Los Angeles 19, Cal.
200 MG LAFAYETTE STREET • NEW YORK 12, N. Y.

For more information circle 130 on inquiry card.



THE SPOT GALVANOMETER

Laboratory Accuracy . . . Shop Ruggedness

The Cambridge Spot Galvanometer provides a complete outfit—galvanometer, lamp and scale—in one self-contained plastic case. It is robust, has a stable zero and does not require accurate levelling. The sharply defined spot can easily be read at a distance. The lamp may be operated on A.C. service current or 4-volt battery. Sensitivity in mm. on scale is from 19, 30 and 170 per micro-ampere using coils of 20, 50 and 400 ohms respectively. Scale can be read to 0.2 mm. Send for Bulletin 271.

CAMBRIDGE INSTRUMENT CO., INC.
3554 Grand Central Terminal, New York 17, N. Y.
PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

For more information circle 131 on inquiry card.

MARSHALLTOWN

THE RIGHT GAUGE FOR YOUR SPECIFIC NEEDS

Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

- PRESSURE
- VACUUM
- COMPOUND
- ALTITUDE
- COMBINATION
- DIAPHRAGM
- HYDRAULIC
- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS (Vapor Tension or Bi-Metal)

WRITE TODAY FOR COMPLETE INFORMATION

MARSHALLTOWN MFG. COMPANY
MARSHALLTOWN 3, IOWA

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Outstanding Accuracy

PALMER

Dial Thermometer

Check these functional features

- Direct-drive Bourdon Coil with a filled system for longer lasting accuracy.
- Stem can be placed at any desired angle and case can be rotated to most readable position.
- External calibration for zero setting.
- Unaffected by stem alignment.
- Accurate to one scale division.
- No sticking at any temperature.
- Non-corrosive case.

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

2515 Norwood Ave., Cincinnati 12, O.

For more information circle **133** on inquiry card.

new literature

AUTOMATION

PHOTOELECTRIC SYSTEMS. 24-page Bulletin PA 561, contains specs, descriptive data, and operationl charts, for photoelectric systems for industrial control applications, including miniature and sub-miniature photoelectric receivers and light sources.—Electronics Corp. of Am. Photoswitch Div., 1 Memorial Dr., Cambridge, Mass.

For more information circle **287** on inquiry card.

OFFICE AUTOMATION. 40-page pocket-size booklet describes "Sixteen Effective Tools for Effective Management," visual aids for control of orders, purchases, inventory, production, etc., including boards, files, cabinets, tabulating cards, etc.—Wassel Organization Inc., P. O. Box 390, Westport, Conn.

For more information circle **288** on inquiry card.

AUTOMATIC FEEDERS. 8-page brochure Form 3R3384 describes automatic parts feeders including non-mar feeder-orientors for handling fragile and highly finished parts, elevating oriented feed hoppers, stack feeders, and rotary hoppers.—Radio Corp. of America, Industrial Automation Equipment Section, Camden 2, N. J.

For more information circle **289** on inquiry card.

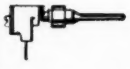
SERVOS

SERVO ANALYSIS. "Servo Calculator," a plotting tool aid in the solution of network problems in servo analysis may be obtained at no charge by writing on company letterhead to Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y.

For more information circle **290** on inquiry card.

ELECTROMECHANICAL ACTUATION. 8-page loose-leaf binder offers an electromechanical-actuator glossary.—Hoover Electric Co., 2100 South Stoner Ave., Los Angeles 25, Calif.

For more information circle **291** on inquiry card.



TEMPERATURE

MULTI-THERMOCOUPLES. 22-page Engineering Data Bulletin, EDS-47 describes long, multithermocouple assemblies for temperature readings at various levels in deep vessels, reactors, catalyst beds, furnaces, etc. Includes details on various standard types of construction and components.—Thermo Electric Co., Inc., Saddle Brook, N. J.

For more information circle **292** on inquiry card.

BI-METAL THERMOMETERS. 8-page Bulletin 13E lists complete specifications and prices on more than 100 angle-form, straight-form and special-purpose thermometers.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

For more information circle **293** on inquiry card.

THERMOCOUPLES. 36-page Catalog 1885 describes thermocouple assemblies and pressure sealing glands introducing new additions such as Type "C" bare-wire thermocouple glands, roll temperature thermocouples, etc.—Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y.

For more information circle **294** on inquiry card.

THERMOCOUPLE WIRE. 4-page Bulletin TC-2 tells with charts and tables story of exclusive color-coded dirt- and contamination-resistant packaging of platinum-type thermocouple wire.—J. Bishop & Co., Platinum Works, Malvern, Penna.

For more information circle **295** on inquiry card.

THERMOCOUPLES. 8-page Catalog 3.8A describes AerOpak thermocouples for users in the nuclear, aircraft, industrial and process fields.—Aero Research Instrument Co., 315 N. Aberdeen St., Chicago 7, Ill.

For more information circle **296** on inquiry card.

FLOW, LEVEL

STEAM METER. 8-page Bulletin 400-P25 describes Shuntflo Meter Model SMDH Style 57 for precise metering of steam in 1" and 1½" lines—Builders-Providence, Div. of B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I.

For more information circle **297** on inquiry card.

LIQUID LEVEL GAGES. Slide Selector of correct size and type of liquid level gages and valves condenses specifications, sizes and other data in easy-to-use form.—Jerguson Gage & Valve Co., 80 Adams St., Burlington, Mass.

For more information circle **298** on inquiry card.

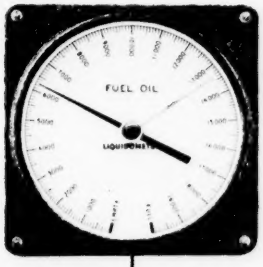
HIGH-CAPACITY FLOWRATOR. 2-page Specification Bulletin 10A1156 describes meter suitable for flow rates up to 4,360 gpm.—Fischer & Porter Co., 819 Jacksonville Rd., Hatboro, Penna.

For more information circle **299** on inquiry card.

PRESSURE, VACUUM

PRESSURE GAGES. 40-page Catalog NR-198 contains details for over 250 different Acragage solid-front models, including pressure, vacuum, compound, pneumatic and electric transmitter, receiver, and test gages; chemical protectors, and various gage accessories.—International Register Co., Instrument Div., 2620 W. Washington Blvd., Chicago 6, Ill.

For more information circle **300** on inquiry card.



100% AUTOMATIC TANK GAUGING

Dependable remote reading tank contents gauges using a closed hydraulic transmission system. No power required.

Several sizes available. Approved by Underwriters Laboratories and Factory Mutual. UL approved switches.

Write for complete details, to Dept. E

Since 1920 of proven quality

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For more information circle **134** on inquiry card.

NEW VIBRATING CAPACITOR

A vibrating-reed type capacitance modulator for use in measuring currents as low as 10^{-16} amperes.

Long term stability for process control. Drift ±0.2 millivolts per day, non-cum.

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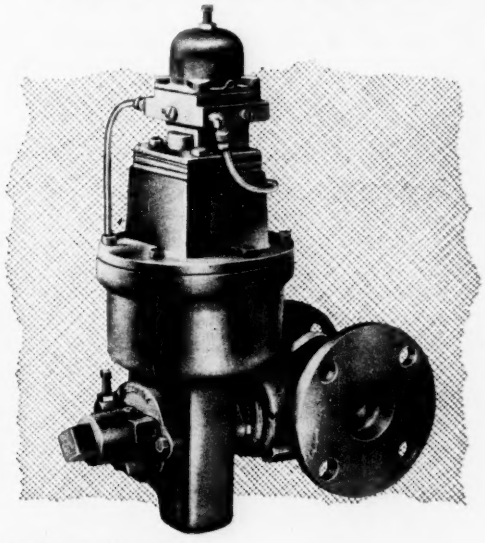
For more information circle **135** on inquiry card.

MAKE NO MISTAKE...

Choose DeZurik Control Valves

FOR MORE OF THE FEATURES YOU WANT!



STRAIGHT-THRU FLOW
No Turbulence, No Packed Solids, No Erosion

POSITIVE OPERATION
Quick, Accurate Response, No Drifting, No Hunting

MANUAL OPERATION
Not a "Built-On" Extra. Always Instantly Accessible

WIDE RANGE
Of Body Materials Available

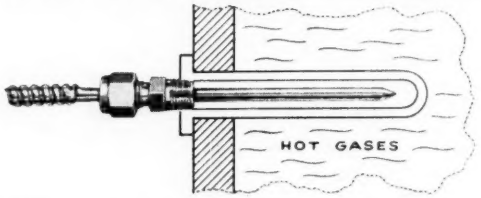
DESIGNED FOR MINIMUM MAINTENANCE AT LOWER COST.
For more information on DeZurik Control Valves, see the DeZurik representative in your area or write to

DeZURIK CORPORATION
SARTELL, MINNESOTA

For more information circle **136** on inquiry card.

Thermocouple Life Increased Up To 135 Times

With T-E's *Ceramo*® Construction



For measuring all types of process temperatures, T-E's "Ceramo" construction—ceramic insulation, metal sheathing—provides a tremendous increase in thermocouple life over conventional, open-end types. In a typical application, enclosed hot junction, ⅛" O.D. "Ceramo" thermocouples were used recently in a hydro carbon cracking unit operating continuously at 1616° F. "Ceramo" thermocouples lasted 7 to 9 months—*while 14 gage bare wire thermocouples lasted but 2 to 14 days.* And there was no significant difference in response. "Ceramo" thermocouples are available in all standard calibrations. Overall diameters—1/25" to 1-7/16".

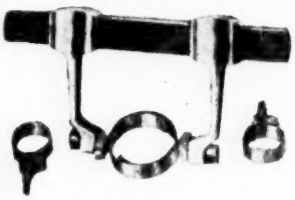
Write for Bulletin 325-F.

Thermo Electric Co. Inc.
SADDLE BROOK, NEW JERSEY
In Canada—THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

For more information circle **137** on inquiry card.

THE ROLYN *(Snake) Plier*

An indispensable tool for assembly and dismantling of optical, radio, scientific instruments and all kinds of mechanical equipment.



The SNAKE PLIER consists of two coil springs with their turns interleaved, attached to two arms projecting from and sliding for adjustment of diameter on the main supporting bar. Two sets of springs are supplied and additional sizes are available.

Ideal for use in all fields where a positive friction grip is required in loosening, or tightening, of the most delicate and fragile threads, or thin wall tubing without danger of damaging, or of marking. Can be used on right or left hand threads. It is equally effective at any angle.

Exhaustive tests in Government workshops and research depts. have proved the efficiency of the Rolyn SNAKE PLIER.

PRICE POSTPAID **$28.60**

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For more information circle **138** on inquiry card.

T LAMINATED & SOLID GLASS **FILTERS** INDUSTRIAL • SCIENTIFIC • PHOTOGRAPHIC

I PRECISION OPTICS WINDOWS • PRISMS • WEDGES

F SPECIALIZED GLASS VYCOR • PYREX • QUARTZ

F PRECISION HOLE DRILLING TOLERANCES TO .0001"

E PRECISION EDGING SAWING, MACHINING ON ALL TYPES OF GLASS & CERAMICS

N PRECISION OPTICAL MACHINING METAL LENS MOUNTS • BARRELS • EYEPIECES

AUTOMATIC SCREW MACHINES TO 4" DIA. — ALSO HAND SCREW MACHINES — ENGLISH & METRIC THREADS OUR SPECIALTY.

Write for Filter Transmission Curve Catalog.

Tiffen® QUALITY PRODUCTS

TIFFEN MARKETING CO.
INDUSTRIAL DIVISION
71 Jane St., Roslyn Heights, L.I., N.Y.

For more information circle **139** on inquiry card.

NEW LITERATURE

ACCELEROMETERS, ETC. 4-page brochure highlights Glennite instruments for shock, vibration, pressure, inertial control, and temperature. Included are transducers, amplifiers, cables and connectors, vibrators, interferometers, strain gages, accelerometers, temperature probes, and miniature airborne recorders.—Gulton Instrumentation Div., Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

For more information circle **301** on inquiry card.

MANOMETERS. 12-page catalog presents U-tube, well-type, and inclined-tube manometers, also manometer theory.—Trimount Instrument Co., 3119 West Lake St., Chicago 12, Ill.

For more information circle **302** on inquiry card.

VACUUM GAGES. 12-page folder contains spec sheets on Televac indicating and recording thermocouple and ionization gages, also precision-bore glass tubing, and scientific glassware.—George E. Fredericks Co., Bethayres, Penna.

For more information circle **303** on inquiry card.

MANOMETERS. 24-page Catalog 2008 includes sections on U-type, well-type (single- and multi-tube) and inclined-tube manometers, manometer indicating liquids, and accessory equipment.—King Engineering Corp., Box 680, Ann Arbor, Mich.

For more information circle **304** on inquiry card.

TIME, COUNT

COUNTER-CONTROLLER. 4-page folder describes Series 320 dual preset counter-controllers for coil winding, motor speed control, shearing to length, batching, packaging, variable pulse interval generation, and process programming.—Computer Measurements Corp., 5528 Vineland Ave., North Hollywood, Calif.

For more information circle **305** on inquiry card.

TIMERS. 8-page bulletin describes drum type controllers.—Sealy Instrument Co., Inc., Subsidiary of Aeronautical Mfg. Corp., P. O. Box. 387, Niagara Falls, N. Y.

For more information circle **306** on inquiry card.

ANALYTICAL, LABORATORY

ULTRACENTRIFUGE. 12-page Brochure 5BL-2 gives full information on Model L Preparative Ultracentrifuge. Contains also description of the high-temperature and high-vacuum special versions of the Model L.—Beckman/Spinco Div., Stanford Industrial Park, Palo Alto, Calif.

For more information circle **307** on inquiry card.

PLASTIC LABWARE. 16-page Catalog P58 contains illustrated and indexed description of 78 different types of plastic apparatus, from beakers to vacuum drums made of polyethylene, polypropylene, Teflon, polystyrene, polyvinyl chloride and acrylic resin, with tables outlining the properties of each.—Will Corp., Rochester 3, N. Y.

For more information circle **308** on inquiry card.

GAS ANALYZER. 2-page bulletin describes the Thermal Gas Analyzer Model 101 for the analysis of O_2, He, and CO_2 in gas mixtures.—Instrumentation Associates, 17 West 60 St., New York 23, N. Y.

For more information circle **309** on inquiry card.

INDUSTRIAL GAS CHROMATOGRAPH. 2-page Bulletin GC-4117 describes and specifies the multi-stream, multi-component Model 220 for chromatographic analyses.—Beckman/Scientific and Process Instruments Div., 2500 Fullerton Rd., Fullerton, Calif.

For more information circle **310** on inquiry card.

OPTICAL

INFRARED FILTERS. 12-page Progress Reports No. 3 summarizes latest technical data on Interference Filters for the near-infrared region.—Bausch & Lomb Optical Co., Rochester 2, N. Y.

For more information circle **311** on inquiry card.

INTERFERENCE BAND FILTERS. 2-page Bulletin 302-IR describes Schott Interference Band Filters, particularly for the near-infrared from 1000-2000mu.—Fish-Schurman Corp., 70 Portman Rd., New Rochelle, N. Y.

For more information circle **312** on inquiry card.

DATA HANDLING

TAPE LOOP ADAPTER. 2-page Bulletin 1613 describes application of data handling accessory, Cat. No. 5-049, "which converts from reel to loop operation in just 2 minutes."—Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.

For more information circle **313** on inquiry card.

A/D CONVERTERS. 6-page brochure contains comprehensive description of Transicon Datracs—modularized, transistorized, analog-to-digital converters, digital-to-analog converters, and alarm limit monitors.—Epsco Inc., 588 Commonwealth Ave., Boston 15, Mass.

For more information circle **314** on inquiry card.

COMPUTATION CENTERS. 20-page Bulletin CC-821 describes in detail the analog computing equipment installed at the company's computation centers in Princeton, N. J.; Los Angeles, Calif.; and Brussels, Belgium.—Electronic Associates, Inc., Technical Literature Group, Long Branch, N. J.

For more information circle **315** on inquiry card.

DIGITAL EQUIPMENT. 12-page Brochure "A Systematic Approach to Electronic Digital Equipment Design," describes company's specialty of developing, designing, and building electronic-digital equipment systems and system components to meet special requirements.—Control Data Corp., 501 Park Ave., Minneapolis 15, Minn.

For more information circle **316** on inquiry card.

MAGNETIC TAPE RECORDER/REPRODUCER. 16-page brochure on the Model FR-100A provides details as to how this modular equipment is being used.—Ampex Corp., Instrumentation Div., 860 Charter St., Redwood City, Calif.

For more information circle **317** on inquiry card.

For your library . . .

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by M. H. Aronson. "Comprehensive source book on instrument circuitry," this complete home-study text includes 458 multiple-choice questions (and answers), 215 illustrations, 10 tables, comprehensive index. Paperbound, 324 pages, 1958 (revised third edition) **$2.00**

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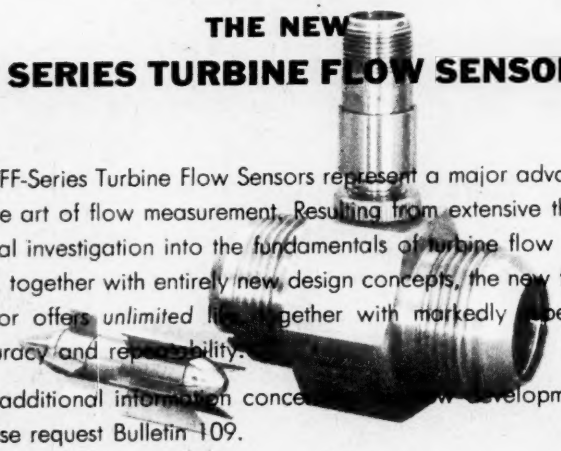

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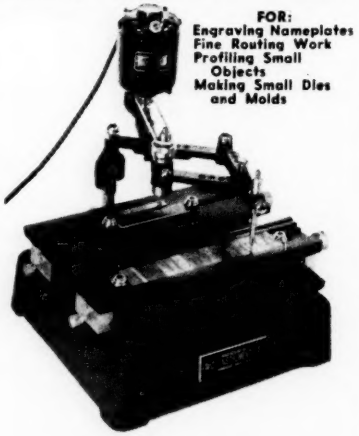

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NEW LITERATURE

TAPE-WOUND BOBBIN CORES. 16-page Bulletin BC-203 contains design information and core data compiled from tests performed using pulse test equipment and electronic integration techniques.—Magnetics Inc., Butler, Penna.

For more information circle **318** on inquiry card.

COMPUTER APPLICATION. 4-page Application Report S-449 describes use of the LGP-30 electronic digital computer in creating heat exchanger designs for the Brown Fintube Co., Elyria, Ohio.—Royal McBee Corp., Port Chester, N. Y.

For more information circle **319** on inquiry card.

PRECISION ANALOG COMPUTER. 18-page brochure and folder describes the MC-5800 Master Precision Analog Computer. Fourteen pages of specifications and description are included in a 4-page folder.— Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N. Y.

For more information circle **320** on inquiry card.

TESTING

CALIBRATING AND WEIGHING. 4-page Bulletin 169 describes operation and specifications of completely-transistorized, battery-powered calibrating and weighing system for load cells, torque-measuring dynamometers, thrust stands, testing machines and other force measurement equipment. —Morehouse Machine Co., 1742 Sixth Ave., York, Penna.

For more information circle **321** on inquiry card.

ELECTRONIC TESTERS. 64-page Catalog E lists 38 items of new precision electronic test equipment. It also contains a helpful discussion of correct techniques for use of signal generators, plus a useful reactance nomograph.—Measurements a Div. of McGraw-Edison, Dept. C, P. O. Box 180, Boonton, N. J.

For more information circle **322** on inquiry card.

ABRASION TESTER. 2-page Leaflet NL48 describes Model PE1 for testing porcelain enamel finish.—Gardner Laboratory, Inc., P. O. Box 5728, Bethesda 14, Md.

For more information circle **323** on inquiry card.

TEST EQUIPMENT. 8-page Bulletin 2060 covers volt-ohmmeters, vacuum tube volt-ohmmeters, microtesters, and refrigeration and air conditioning test equipment.—Simpson Electric Co., 5200 West Kinzie St., Chicago 44, Ill.

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MOBILE TEST LAB. 16-page Brochure ML-100 describes how engineering testing programs for soils explorations, soils studies, and quality control of concrete and asphalt can be carried out with a line of mobile testing labs. —Soiltest, Inc. 4711 W. North Ave., Chicago 39, Ill.

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SYNCHRO TESTING. 14-page Technical Bulletin describes synchro test methods. It emphasizes the application of the Synchro and Resolver Bridge for both component and system measurements.—Theta Instrument Corp., 48 Pine St., East Paterson, N. J.

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ENVIRONMENTAL TEST CHAMBERS. 2-page Bulletin SP 58 describes Walk-in Altitude; Sand and Dust; and other testing chambers built to customers' specifications.—American Research Corp., Farmington, Conn.

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TUBING

SMALL-DIAMETER TUBING. 12-page Bulletin 41 gives the form (seamless or Weldrawn), characteristics, and applications of 63 standard- and 26 special-material cold-drawn small tubing. The tubing materials are grouped as carbon, alloy and stainless steels; nickel and nickel alloys; copper-base alloys; glass-sealing alloys; and reactive metals.—Superior Tube Co., 1564 Germantown Ave., Norristown, Penna.

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SMALL ALLOY TUBING. Data book "Precision Tubing for All Industries" discusses drawing, annealing, finishing and testing of small alloy tubing, including precision tubing for instruments and gages of indicators, Bourdon tubing and pointer tubing, also the exclusive, shielded-wire Coaxitube.—Send request giving name and address of company, together with title, to Dept. 15, Precision Tube Co., North Wales, Penna.

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ELECTRICAL, ELECTRONIC INSTRUMENTS

LEAK DETECTORS. 12-page Bulletin GEA-6817 describes in text, tables, and pictures characteristics and applications of new halogen-type leak detectors with new control unit, which can be used with any of 4 detector heads.—General Electric Co., Schenectady 5, N. Y.

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PULSE GENERATORS. 4-page Short-Form Catalog 1958-59 covers specifications of pulse generators, block units for special-purpose pulse instrumentation, magnetic-core testing equipment, and electronic counters.—Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

For more information circle **331** on inquiry card.

AMPLIFIER. 16-page Tentative Data Sheet contains descriptive, specification, and application data; and circuits of the Model UPA-2 Utility Packaged Amplifier used to activate external feedback network.—George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass.

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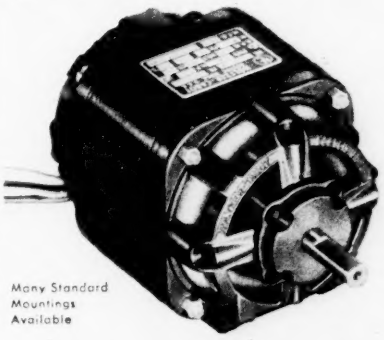

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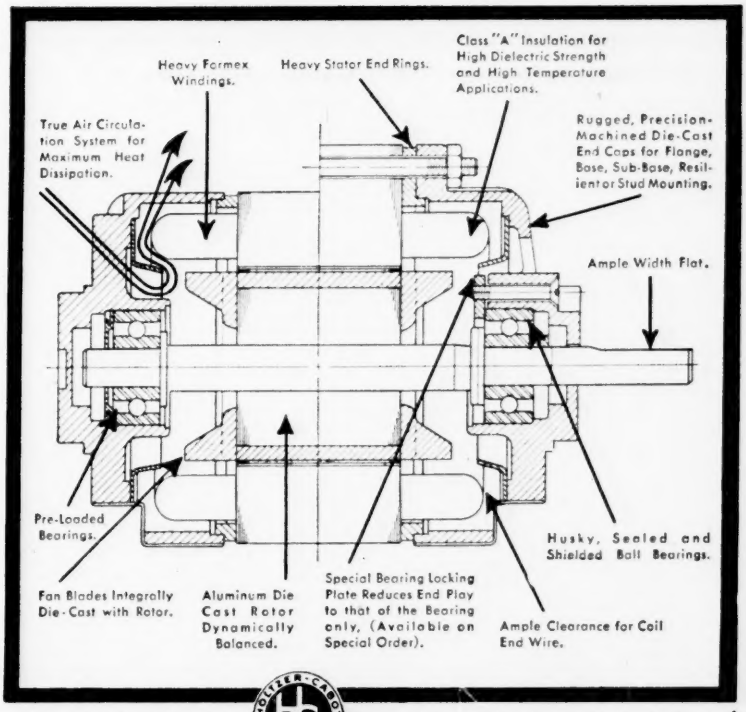
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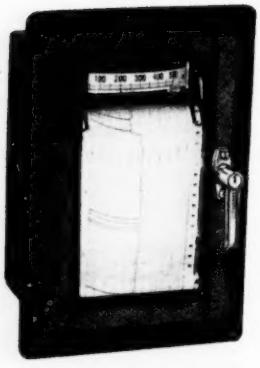

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COMMUTATORS. 4-page Product Bulletin 103 presents information on airborne and ground-based commutators.—Wiancko Engineering Co., 255 North Halstead Ave., Pasadena, Calif.

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CR OSCILLOSCOPE. 4-page illustrated folder provides specs and data on general-purpose Model 7000-B.—Waters Mfg., Inc., Wayland, Mass.

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VARIABLE PULSER. 2-page technical Bulletin 1010 describes operation of Model 1010 Variable Pulser for converting any type signal source into standardized pulses of controlled amplitude and duration.—Technitrol Engineering Co., 1952 E. Allegheny Ave., Phila. 34, Pa.

For more information circle **336** on inquiry card.

TRANSMITTER PROTECTION. 4-page Engineering Bulletin 60 describes and explains uses of directional couplers and meter relays for transmitter and transmission line protection.—Rixon Electronics Inc., 2414 Reedie Dr., Silver Spring, Md.

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MICROWAVE INSTRUMENTS. 6-page folder illustrates and describes microwave line including spectrum analyzers, wave detector, amplifier, power bridge, frequency meters, etc.—Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

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TRANSFORMERS. 32-page Catalog S104 covers over 750 transformers for industrial, communications, television and radio applications.—Chicago Standard Transformer Corp., 3501 Addison St., Chicago 18, Ill.

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WIDEBAND DC AMPLIFIER. 4-page Bulletin A1 132.1 describes high-current, high-voltage, Wideband D-C amplifier for applications requiring a differential, isolated or grounded amplifier.—Computer Engineering Associates, Inc., 350 North Halstead, Pasadena, Calif.

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PORTABLE OSCILLOSCOPE. 2-page bulletin gives detailed technical data on Model 622A professional 5" oscilloscope.—Hycon Electronics, Inc., 370 So. Fair Oaks, Pasadena, Calif.

For more information circle **341** on inquiry card.

HF POWER METER. 4-page hp Journal, Aug. 1958, gives specifications and reviews applications of automatic d-c to X-band Calorimetric Power Meter, Model 434A.—Hewlett-Packard Co., 275 Page Mill, Palo Alto, Calif.

For more information circle **342** on inquiry card.

SCIENTIFIC INSTRUMENTS. 24-page catalog describes Pye amplifiers and voltmeters; fluxmeters; galvanometers; Kelvin, and other type bridges. —Ealing Corp., 40 University Rd., Cambridge 38, Mass.

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SWITCHES, RELAYS

SNAP-ACTING SWITCHES. 4-page Bulletin 858A describes and specifies Type A precision snap-acting switches for use in automatic devices, signal and alarm systems, and automatic controls.—Unimax Switch Div. The W. L. Maxson Corp., Ives Rd., Wallingford, Conn.

For more information circle **344** on inquiry card.

TRANSISTOR PROTECTOR. Catalog sheet describes transistorized limit relay which provides circuit protection against over-voltage and over-current conditions.—Electronic Research Associates, Inc., 67 Factory Pl., Cedar Grove, N. J.

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RELAYS. 20-page Catalog 159 includes specifications and dimensional diagrams of microminiature rotary relays, telephone type relays, etc.—Magnecraft Electric Co., 3350L West Grand Ave., Chicago 51, Ill.

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RESISTORS, POTENTIOMETERS

POWER RESISTORS. 2-page Bulletin 153 describes wire-wound power resistors which feature a jacket of silicone-ceramic material molded around the resistor to provide a uniform, moisture-proof, high insulation resistance covering.—Ohmite Mfg. Co., 3699 Howard St., Skokie, Ill.

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OIL-FILLED POTENTIOMETERS. 7-page Data Sheet 1482 describes three multi-turn, liquid-filled potentiometers: a ten-turn, 1-½" dia (Model 4203); a three-turn (Model 4713); and a ten-turn 2" dia (Model 4613). Contains power input charts, dimensional drawings, electrical and mechanical specifications, and standard coil data.—Helipot Div., of Beckman Instrs. Co., Technical Information Service, Fullerton, Calif.

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POWER SUPPLIES

POWER SUPPLIES. 4-page Bulletin 350A includes new models and complete specifications of electronic power packs for transistor and lab work, automatic control, computers, and general utility.—Electronic Measurements Co., Inc., Eatontown, N. J.

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NEW LITERATURE

D-C POWER SUPPLIES. 2-page Catalog Sheet describes Hypac solid-state, high-voltage transistorized, regulated power packs producing high-voltage output from either d-c inputs.—E. R. A. Pacific, Inc., 1760 Stanford St., Santa Monica, Calif.

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ELECTRICAL, ELECTRONIC COMPONENTS

ELECTRONIC COMPONENTS. 452-page General Catalog lists over 32,000 items. Featured is equipment for industrial maintenance, research and production requirements. Available free on request.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

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TERMINAL BLOCKS. 6-page brochure gives information on solderless terminal blocks for computer applications, designed to accept "AMP 53" solderless taper pins.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information circle **352** on inquiry card.

ELECTRONIC EQUIPMENT. 388-page Catalog 69 illustrates, describes, and prices industrial-electronics, high-fidelity, radio, TV, and amateur equipment.—Newark Electric Co. 223 W. Madison St., Chicago 6, Ill.

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CAPACITORS. 24-page Capacitor Substitution Cross Index provides over 3,525 listings of "preferred" C-D twist prongs and tubular electrolytics to replace Aerovox, Mallory, Pyramid, Sangamo and Sprague capacitors.—Cornell-Dubilier Electric Corp., South Plainfield, N. J.

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ELECTRONIC COMPONENTS. 24-page Basic Catalog 858 contains general environmental information on toroidal coils, filters, magnetic amplifiers, dc to dc converters, and laminated transformers.—Communication Accessories Co., Lee's Summit, Mo.

For more information circle **355** on inquiry card.

WIRES, CONNECTORS

AUDIO/ELECTRONIC PLUGS. 4-page catalog describes new Cannon XLR Audio/Electronic connector series for use on microphones, tape recorders, amplifiers, test instrumentation, computers, and other electronic instruments.—Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

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WIRE MARKERS. 8-page Bulletin 130 describes and lists 4,000 different self-adhesive Perma-Code wire markers made of vinyl-cloth, aluminum foil, polyester film, epoxy resin, acetate cloth, and glass cloth.—W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.

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MINIATURE CONNECTORS. 4-page Summer 1958 issue of "Deutsch Deflections" contains information on miniature connectors with snap-in contacts.—The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.

For more information circle **358** on inquiry card.

MOLDED CABLE ASSEMBLIES. 4-page Catalog Supplement S-592 covers line of molded cable assemblies, including straight and right-angle phone plugs, phone-extension jax, straight and right-angle phono plugs; and phono extension jax.—Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, Ill.

For more information circle **359** on inquiry card.

CONTROLS CABLES. 4-page Bulletin CC10 lists various sizes of control cables and describes the sheaths and insulations used.—Triangle Conduit & Cable Co., Inc., New Brunswick, N. J.

For more information circle **360** on inquiry card.

MATERIALS

MAGNESIUM IN ELECTRONICS. 20-page booklet describes the use of magnesium in airborne and air-transportable electronics equipment.—The Dow Chemical Co., Midland, Mich.

For more information circle **361** on inquiry card.

TANTALUM SHEET AND FOIL. 6-page Price List 2.602-1 covers tantalum for all end uses except capacitors.—Fansteel Metallurgical Corp., Metals and Fabrication Div., North Chicago, Ill.

For more information circle **362** on inquiry card.

CARBON AND GRAPHITE. 56-page Catalog 40B gives detailed properties, application, and performance data on bearing materials, seal rings, dash pot plungers, and friction segments made of carbon or graphite.—Stackpole Carbon Co., St. Marys, Penna.

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BRAZING ALLOYS. 6-page Catalog V-124 describes line of Wesgo ultra-high-purity, low-vapor-pressure brazing alloys for vacuum systems.—Western Gold & Platinum Co., Belmont, Calif.

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REFERENCE FOR PLASTICS. 138-page non-technical reference book contains tables and data on almost every plastic material, how they came about, how they are used, and why; physical properties; types of molding; notes on machining and inserts.—Boonton Molding Co., 326 Myrtle Ave., Boonton, N. J.

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FABRICATION

FABRICATION AND TESTING. 20-page booklet "Telex is a Manufacturer's Manufacturer" outlines sub-contract facilities for the fabrication and testing of electronic assemblies.—Telex, 1637 Eustis, St. Paul 1, Minn.

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SAND BLAST BOOTH. 2-page specification sheet illustrates and describes small-size portable Port-A-Blast (24" x 24" x 32½") which confines abrasives and dust.—Lindberg Products Co., P. O. Box 908, Lakeport, Calif.

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MISCELLANEOUS

WATER VALVES. 4-page Technical Bulletin W-17 describes Surface Wash Water Valves for Filters which are used also for controlling the flow of water to the filters.—Golden-Anderson Valve Specialty Co., 1285 Ridge Ave., Pittsburgh 33, Pa.

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ULTRASONIC EQUIPMENT. 4-page Short Form Catalog illustrates, describes and tabulates maker's Son-Blaster line of generators, submersible transducers, and transducerized tanks.—Narda Ultrasonics Corp., 625 Main St., Westbury, L. I., N. Y.

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DRAFTING EQUIPMENT. 208-page Catalog 22D illustrates and describes "everything for drafting, surveying, and printmaking."—Eugene Dietzgen Co., 2425 N. Sheffield Ave., Chicago 14, Ill.

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CONTROL/DISPLAY LAYOUT KITS. 10-page booklet contains information on how to use special plastic laminated pictorials for the layout of controls on panels and consoles. Provides instructions on performing maintenance analyses and schematic systems studies.—Michelson-Peters Control Displays, 15537 Ventura Blvd., Encino, Calif.

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PARTS CLEANERS. 4-page bulletin describes high-velocity spray-clean technique and apparatus for vacuum-tube and other components, bearings, gear trains, switches, etc.—Cobehn, Inc., Passaic Ave., Caldwell, N. J.

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GEAR DRIVES. 4-page Catalog IA-58 covers right-angle bevel-gear-drive applications such as running a timing camshaft on a bagmaking machine, operating limit switches on several types of presses, and actuating a discharge agitator for a powdered-milk bin.—Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J.

For more information circle **373** on inquiry card.

NUCLEAR INSTRUMENTATION. Model DM12 Linear Count Rate Meter is described in 2-page Bulletin 58-124.—BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.

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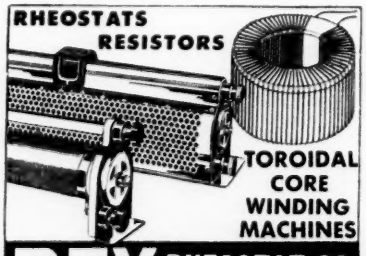

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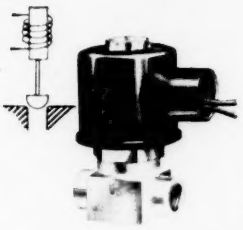

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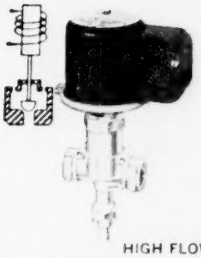

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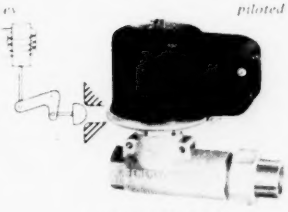

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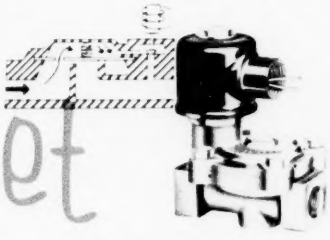

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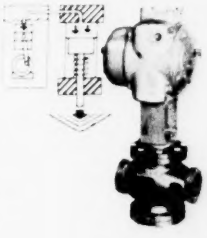

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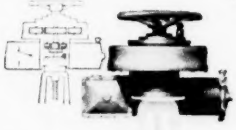

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